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QUANTUM MULTIPLIERS AND MIXERS

FOURTH QUARTERLY
PROGRESS REPORT

By

V. E. Derr and G. W. Bechtold

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QUANTUM MULTIPLIERS AND MIXERS

Fourth Quarterly Progress Report

1 February 1966 through 30 April 1966

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For

U. S. Army Electronics Command, Fort Monmouth, N. J.

Distribution Statement

CONTENTS

ILLUSTRATIONS

PURPOSE

Experimental and theoretical analysis will be conducted to determine
the power conversion efficiencies for harmonic generation due to nonlinear
quantum susceptibilities. Analysis of partly resonant two-level schemes
will be conducted, but emphasis will be placed on the investigation of
resonant harmonic generation within gaseous media, where two levels are
in resonance with the harmonic output, and intermediate levels can be
used to reduce pump power requirements for operation with optimum effi-
ciency. Of primary importance in the experimental phase of work is the
development of suitable resonant structures to support the multiple quan-
tum system.

ABSTRACT

The difficulty of obtaining a large filling factor with crossed interferometers at the fundamental and harmonic frequency was discussed in the last quarterly report. The use of a beam splitter to couple the two frequencies has been proposed. The design and preliminary testing of a metal strip and a dielectric sheet beam splitter was accomplished in this quarter. Fabrication of a beam splitter is a difficult task because of the necessity of preserving the resonator Q with the beam splitter installed. This problem is discussed.

Several asymmetric gases for use in the totally resonant are still under investigation. Because of the corrosive and toxic properties of many of these gases, emphasis has been placed on a search for a gas with the proper energy levels that can be handled in a conventional vacuum system. A tabulation of gases under consideration, and their toxicity and handling problems, is given in the body of this report. Methylene chloride, methylene fluoride, and difluoroethylene appear to have the best handling characteristics. A possible scheme for pumping methylene chloride ha. been found. Further evaluation of the other gases has been started. Energy levels for methylene fluoride, difluoroethylene, formaldehyde, vinyl cyanide, benzonitrile and nitrosyl chloride are given in Appendix A. A nickel monel vacuum system was constructed to test the corrosive properties of these gases.

The experimental effort during the fourth quarter is reviewed. Major emphasis was placed on high power tests for the two-level scheme and parallel plate interferometer and beam splitting tests for the totally resonant system. In the area of the two-level system a sapphire window has been designed and fabricated. This window was successfully operated at 30 kW in a corrosive atmosphere. Martin Company purchased an inverted coaxial tunable magnetron to replace the Microwave Associates' magnetron. Since methyl fluoride decomposes forming hydrofluoric acid in the presence of the high power microwave field, the microwave plumbing has been nickel plated. Fluroform gas has also been tried in the two-level system. This gas is very inert thermally and did not decompose when the high power microwave energy was applied. The totally resonant experiments included tests on the gold plated nickel interferometers at 40 GHz and 120 GHz. Beam splitters were designed and tests performed.

Quantum mechanical calculations were performed to determine the time dependence of the expectation value of the polarization operator and are presented in Appendix B.

CONFERENCES AND PUBLICATIONS

G. W. Bechtold of the Martin Company Physical Sciences Research Laboratory (Orlando, Florida) conferred with Dr. Harro Andresen, Contract Monitor, at the United States Army Electronics Command, Fort Monmouth, New Jersey, on 8 February 1966.

I. INTRODUCTION

Multiple quantum effects have been predicted since the introduction of quantum mechanics (Reference 1) and have manifested themselves in many ways. For example, such phenomena have been associated with Raman processes (References 2 through 8), molecular beam transitions (References 9 through 17), and optically pumped schemes (References 18 through 26). More recently, multiple quantum transitions have been observed in the microwave region and the feasibility of frequency conversion because of nonlinear quantum susceptibilities has been experimentally demonstrated (References 27 through 30).

The interesting possibility of producing millimeter and submillimeter radiation from such schemes has led to the consideration of partly resonant (Reference 31) and resonant (References 32 and 33) techniques. From an analysis of the power conversion efficiencies of the two methods, the resonant frequency mixing scheme shows the greater promise for frequency conversion devices in the millimeter region and requires a more careful selection of materials. An effective technique must be devised for obtaining a high filling factor.

In this report, the design of thin metallic strip and dielectric sheet beam splitter is reviewed. The gas handling problem and the experimental work performed during the quarter are discussed.

II. TECHNICAL DISCUSSION

A. DESIGN OF BEAM SPLITTERS

It was shown in the last quarterly report that the filling factor of crossed parallel plate interferometers decrease very rapidly as a function of inter-secting angle. One technique used to overcome this problem is the use of a frequency sensitive beam splitter that reflects one of the frequencies in the interaction region and transmits the other frequency. The most prom-ising beam splitters are the polarizing slat grating, grid, interference thin film, and dielectric sheet types. The need to position a beam splitter in the resonator with a minimum change in performance is a major problem. In earlier tests, any perturbation placed between the plates of the resonator decreased the Q to a very low value. Preliminary attempts to place thin metallic strips in the resonator were unsuccessful. Metallic strips act as a waveguide beyond cutoff for one of the resonator frequencies A de-sign calculation of a beam splitter employing this principle is as follows:

$$\alpha_1 = \frac{2\pi}{\lambda_c}\left\{\left(\frac{\lambda}{\lambda_c}\right)^2 - 1\right\}^{\frac{1}{2}}$$

where

α_1 is the attenuation

λ is the operating wavelength

λ_c is the cutoff wavelength

For $\frac{\lambda}{\lambda_c} = 2$; $\lambda = 11$; $\lambda = 0.35$ inch at 35 GHz

If we take $\lambda_c = 0.35 \times 2 \times 2.54$ and length of waveguide (l) equals 2 cm, then the amplitude attenuation is

$$e^{-\alpha l} = e^{-\frac{11 \times 2}{\lambda}} = e^{-24.76}.$$

3

Power attenuation is $e^{-2\alpha l} = e^{-49.52}$. To convert to dB we have power lost (dB) = 10 log χ = 10 log $e^{-49.52}$ = 234 dB. This is the loss for transmission of the fundamental signal through the waveguide operated beyond cutoff. For transmission of the third harmonic signal we have λ/λ_c = 2 x 0.35/(3 x 0.35) = 0.66. Attenuation of 0.05 dB per meter is then read from Figure 5-2-6 of Reference 34.

To determine the spacing of the strips we have λ/λ_c = 2; λ_c = 0.175 and the spacing between strips is $2\alpha = \lambda_c$; α = 0.0875 where α is the spacing between strips.

To obtain the necessary low transmission loss for the higher frequency signal it is necessary to have thin strips that have high conductivity and a high surface finish. There should be a sufficient number of strips and the strips should be high enough to fill the region occupied by the resonator field. One possible fabrication technique would be that of using mylar sheets with gold deposited on the surface. It would then be possible to surface match the air-dielectric interface. A schematic of this reflector design is shown in Figure 1.

The dielectric sheet reflector beam splitter was investigated in more detail than the metal strip reflector. This beam splitter is the microwave equivalent of the optical beam splitter used in spectrometers. A dielectric sheet is placed in the field of the resonator at an oblique angle to the wavefront. A wave impinging on this interface splits into a reflected and transmitted wave. The relative amplitudes of the two components is a function of the angle of incidence, dielectric constant, and thickness of dielectric material. A sample calculation will be performed to compute the required thickness for a sheet of mylar to split the beam into two equal components. The polarization is assumed to be perpendicular and the effect of dielectric loss is neglected in this case. The following equations are given in Chapter 12 of Reference 35:

$$r_{ab} = \frac{n_a \cos \theta_0 - (n_b^2 - n_a^2 \sin^2 \theta_0)^{\frac{1}{2}}}{n_a \cos \theta_0 + (n_b^2 - n_a^2 \sin^2 \theta_0)^{\frac{1}{2}}}$$

where

r_{ab} is the amplitude reflection coefficient

n_a is the index of refraction for medium 1

n_b is the index of refraction for medium 2

θ_0 is the angle of incidence measured from the wave normal.

4

End View
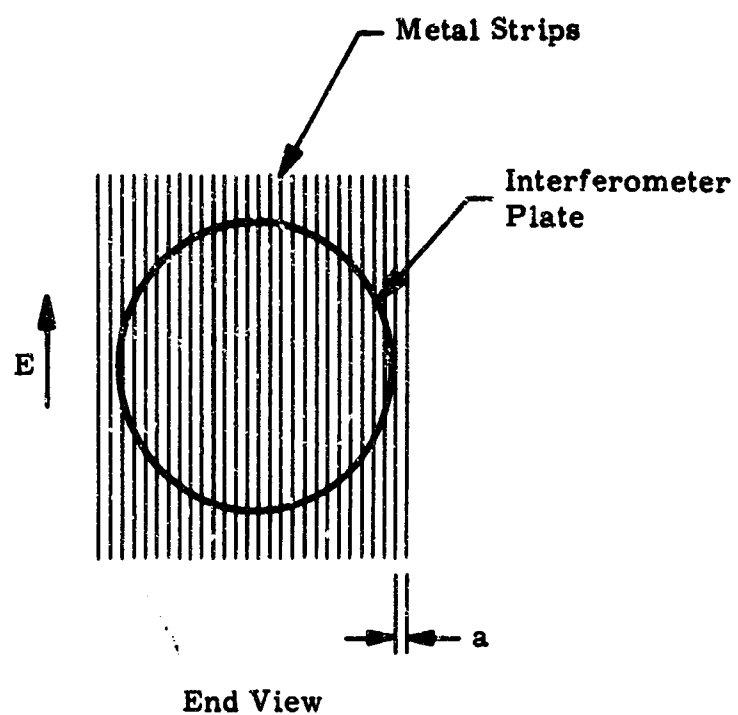
Figure 1. Metal Strip Beam Splitter

If we assume $n_a = 1$ (air) $n_b = 1.48$ (mylar) $\theta_0 = 70°$ sin 70° $= 0.94$
cos 70° $= 0.342$

$$r_{ab} = \frac{0.342 - \left[2.2 - (0.04)^2\right]^{\frac{1}{2}}}{0.342 + \left[2.2 - (0.94)^2\right]^{\frac{1}{2}}} = 0.542.$$

Also, the following relation holds

$$|R|^2 = \frac{4\, r_{ab}^2 \sin\phi}{\left[1 - r_{ab}^2\right]^2 + 4\, r_{ab}^2 \sin^2\phi}$$

where

$|R|^2$ is the power reflection coefficient

ϕ is the electrical thickness of the dielectric sheet
assume $|R|^2 = 0.5$

$$0.5 = \frac{4(0.542)^2 \sin^2\phi}{\left[1 - r_{ab}^2\right]^2 + 4\, r_{ab}^2 \sin^2\phi}; \quad \sin^2\phi = 0.4275;$$
sin $\phi = 0.655$ then $\phi = 40.8$ degree.

To determine the dielectric sheet thickness we have

$$d = \frac{\phi\lambda}{2\pi}\left(n_b^2 - \sin^2\theta_i\right)^{-\frac{1}{2}}$$

$$d = \frac{40.8}{360}\left(n_b^2 - \sin^2\theta\right)^{\frac{1}{2}}\lambda_o = \frac{40.8}{360 \times 1.15}\,\lambda_o = 0.0985$$

where

λ_o is the free space wavelength

$d = 0.0292$ for 40 GHz

$d = 0.0097$ for 120 GHz.

The calculation will not be repeated for the case of parallel polarization since reflection is less when the wave is parallel polarized and the angle of incidence is about 90 degrees. A rough indication of the variation of

·power reflection coefficient versus angle of incidence is shown in Figure
11.4 of Reference 35. Since the plot is given for the parameter $\epsilon/\epsilon_0 = 4$
it is not accurate for the case under consideration.

For the case of a lossy dielectric the mathematics are more compli-
cated. The equation for the power reflection coefficient is as follows:

$$|R|^2 \text{ (lossy)} = |r_{ab}|^2 \frac{\{(1-A^2)^2 + 4A^2 \sin^2 \phi\}}{\{1-A^2|r_{ab}|^2\}^2 + 4A^2|r_{ab}|^2} \sin^2 (\phi + X)$$

where

      A is the transmission amplitude through a lossy medium,
      X is an additional phase shifting term that indicates the dielectric
         loss.

For low loss material such as mylar, the effect is to change the reflec-
tion coefficient slightly. A further consideration is the flatness of the
surface to the impinging wavefront. The plates of the interferometer must
be flat to approximately 100 millions of an inch at 120 GHz for the path
lengths to have equal phase. It is also necessary that the dielectric pos-
sess a greater degree of flatness because of its higher dielectric constant.
Since this velocity is proportional to the square root of the dielectric
constant, it is necessary that the flatness be held to approximately 1.5
times that of the interferometer plates.

The single sheet type of beam splitter that splits the beam into two
equal transmitted and reflected components cannot be used in the double
resonator field because one mode must be transmitted without loss while
the other mode is completely reflected.

Beam splitter designs necessary to obtain maximum reflection of one
signal and maximum transmission of the other signal will now be discussed.
The design of a single dielectric sheet resonator, with the sheet positioned
at an oblique angle to the incident radiation, can be accomplished in two
ways. The sheet could be made of resonant length to the fundamental fre-
quency while reflecting the harmonic frequency. The sheet could also be
made of resonant length to the harmonic frequency while reflecting the
fundamental frequency. The design criteria would obtain 99.9 percent
transmission for the transmitted signal and 99.9 percent reflection for
the reflected signal.

To make the sheet resonant at the fundamental frequency we have

$$d = \frac{\lambda}{2(n^2 - \sin^2 \theta_o)^{\frac{1}{2}}}$$

where the terms have been defined in a previous section for $n^2 = 2.2$ (mylar) $\theta_o = 45$ degree $\lambda = 0.296$

$$d = \frac{0.296}{2 \times 1.3} = 0.114 \text{ inch.}$$

To find the amount of power reflected at the harmonic frequency

$$r_{ab} = \frac{n_a \cos \theta_o - (n_b^2 - n_a^2 \sin^2 \theta_o)^{\frac{1}{2}}}{n_a \cos \theta_o + (n_b^2 - n_a^2 \sin^2 \theta_o)^{\frac{1}{2}}}$$

$$n_a = 1; \cos 45 \text{ degrees} = 0.707; n_b^2 = 2.2$$

$$r_{ab} = \frac{0.707 - (2.2 - 0.5)^{\frac{1}{2}}}{0.707 + (2.2 - 0.5)^{\frac{1}{2}}} = -0.295$$

$$\phi = \frac{2\pi d}{\lambda_o}(K^2 - \sin^2 \theta_o)^{\frac{1}{2}}; \phi = \frac{0.114 \times 360 \times (2.2 - 0.5)^{\frac{1}{2}}}{0.096} = 550$$

$$|R|^2 = \frac{4(0.295)^2 \sin^2 \phi}{1(-0.295)^2 + 4(-0.295)^2 \sin^2 \phi} = 0.0271.$$

In this case, less than 3 percent of the power of the reflected signal is reflected. This loss value of the power reflection coefficient results in a unusable value of Q at the harmonic frequency.

To make the dielectric sheet resonant at the harmonic frequency we have

$$d = \frac{0.114}{3} = 0.033 \quad r_{ab} = -0.295$$

$$\phi = \frac{0.038 \times 360 \times 1.3}{0.296} = 60 \text{ degrees}$$

$$|R|^2 = \frac{4(0.087)(0.75)}{0.83 + 4(0.087)(0.75)} = 0.239.$$

This design is feasible if multilayer dielectric sheets are used to increase the reflectivity. This technique is discussed in Reference 36. However, the fabrication problem is more difficult because the sheets must be flat and the power absorbed from the transmitted signal is increased. The problem of changing the polarization of the reflected wave due to oblique incidence would need investigation.

Another technique with less problems than the single dielectric sheet is the multiple dielectric sheet reflector at normal incidence. A configuration utilizing this type of reflector is shown in Figure 2. The fundamental frequency signal is fed through a horn and lens on one side of the dielectric stack, but the harmonic frequency is fed through a horn and lens to the other side of the dielectric stack. The electrical thickness of the dielectric can be made resonant at either the fundamental frequency or the harmonic frequency. The reflection of the nonresonant signal is calculated from the known thickness of the sheet. If the sheets are a quarter wavelength thick at the harmonic frequency it would require five sheets to realize 99.5 percent reflectivity. This result is obtained from Reference 36 and is calculated for fused quartz with a dielectric constant of 3.8 and
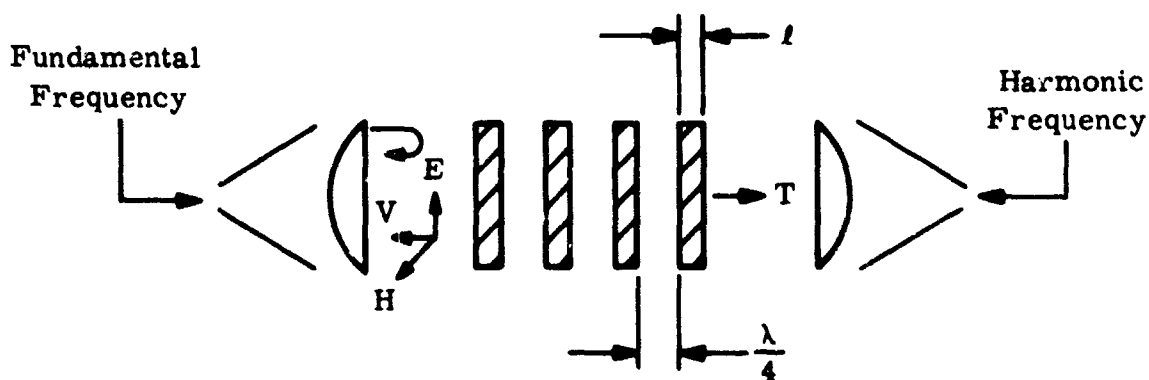
Figure 2. Multiple Dielectric Sheet Reflector

a loss tangent of 0.0004. To calculate the transmission loss for the fundamental frequency signal we have

$$r_{ab} = \frac{n_b - 1}{n_b + 1} = \frac{1.48 - 1}{1.48 + 1} = 0.193$$

r_{ab} is calculated for mylar

$$|R|^2 = \frac{4|r_{ab}|^2 \sin^2 \phi}{\left\{1 - r_{ab}^2\right\}^2 + 4|r_{ab}|^2 \sin^2 \phi} =$$

$$\frac{4(0.193)^2 \, 0.25}{\left\{1 - (0.193)^2\right\}^2 + 4|r_{ab}|^2 \sin^2 \phi} = 0.039.$$

Approximately 4 percent of the incident radiation at the fundamental frequency is reflected. This design will limit the Q of the fundamental frequency signal to a low value. The use of the angle parameter is now being considered.

On the basis of these calculations the metal strip beam splitter that operates as a waveguide beyond cutoff for the fundamental frequency signal is the most promising. Several dielectric sheet beam splitters have been tried and a metal strip beam splitter is being fabricated.

B. GAS SELECTION

The study of gases for use in the totally resonant multiple quantum system was continued in the fourth quarter. Information was accumulated on the following gases:

<u>1</u> Nitrosyl chloride   <u>6</u> Methylene fluoride

<u>2</u> Methylene chloride   <u>7</u> Vinyl cyanide

<u>3</u> Vinylene carbonate   <u>8</u> Hydrazoic acid

<u>4</u> Thionyl fluoride   <u>9</u> Ethylene sulfide

<u>5</u> Benzonitrile   <u>10</u> Diflurosilane

| 11 Isothiocyanic acid | 13 Difluoroethylene |
| 12 Formaldehyde | 14 Nitrosyl fluoride |

The following problem areas associated with gases were investigated:

1 Availability and physical properties of suitable gases

2 Energy levels

3 Fabrication of a vacuum system to determine corrosive properties.

Following is a list of gases that are commercially available and a brief description of each:

1 Nitrosyl chloride is available from Air Products, J. T. Baker Company, and Matheson Company. This gas is nonexplosive, but it is very corrosive and very reactive. Nitrosyl chloride decomposes upon contact with moisture to hydrochloric acid and nitrous acid and creates a very corrosive condition. Nitrosyl chloride is a highly irritating, toxic gas. Its toxicity has not been thoroughly investigated. The effects of nitrosyl chloride would probably fall between those of chlorine and nitrogen oxides and would result in severe irritation of the respiratory tract. The recommended materials for construction are pure nickel, inconel, monel, tantalum, platinum, or glass.

2 Methylene chloride is available from Fluka Company, Dupont Company, and Eastman Kodak Company. This gas is nonflammable and nonexplosive, but people should avoid exposure to high concentrations of its vapors. The threshold limit value (TVL) is 500 parts (by volume) of solvent vapor per million parts of air. Most of the commonly used construction metals such as steel, cast iron, brass, copper, tin, lead, and aluminum can be used satisfactorily under normal conditions of use.

3 Vinylene carbonate was not available from the vendors contacted.

4 Thionyl fluoride is available from Peninsular Chemical Research, Inc. It is a colorless, odorless gas. It does not attack glass or steel. No further information is available at this time.

5 Benzonitrile is available from Fluka Company. It is a flammable liquid and very toxic. 150 ppm for 30 minutes can be fatal.

6 Methylene fluoride is available as Freon 32 from Dupont Company.
It has good thermal stability, and conventional construction ma-
terials can be used. Information is not available on the toxicity of
methylene fluoride.

7 Vinyl cyanide is available from Fluka Company and Eastman Kodak
Company. This gas is poisonous to humans. It forms an explosive
mixture with air (3-17 percent in air). It has a flash point of 32°F
and will polymerize.

8 Hydrazoic acid has an intolerable pungent odor. It is extremely ex-
plosive and very toxic in high concentrations.

9 Ethylene sulfide is available from Fluka Company. This gas will
polymerize under proper conditions. It is irritable to humans and
toxic in proper concentrations.

10 Difluorosilane is not commercially available.

11 Isothiocyanic acid is not commercially available.

12 Formaldehyde is supplied by several vendors.

13 Difluoroethylene is available from Matheson Company and Eastman
Kodak Company. It is a colorless, flammable nontoxic gas. Since
1-1 difluoroethylene is a noncorrosive gas any common or commer-
cially available metal may be used in system construction.

14 Nitrosyl fluoride is available from Ozark Mahoning Company. It
reacts with most constrution materials except nickel, monel, and
inconel. The toxicity of this gas is unknown. Regard this gas as
highly toxic until data are available.

The energy levels of the following gases have been determined and are
tabulated in Appendix A of this report:

1 Methylene fluoride   4 Formaldehyde

2 Difluoroethylene   5 Benzonitrile

3 Vinyl cyanide   6 Nitrosyl chloride

Evaluation of the gas energy levels has not been completed to determine
if four equispaced levels exist. The energy levels of methylene chloride
have been studied and the following possible pumping schemes evolved:

$$\frac{26 \text{ GHz } 34 \text{ GHz } 31 \text{ GHz}}{7_{17} \rightarrow 8_{08} \rightarrow 8_{17} \rightarrow 7_{26}}$$

$$\frac{32 \text{ GHz } 35 \text{ GHz } 24 \text{ GHz}}{8_{18} \rightarrow 9_{09} \rightarrow 9_{18} \rightarrow 8_{27}} .$$

The high J values of these levels indicate the population will not be large. Also, the energy levels are not equispaced. However, it might be possible to pump the first energy level scheme at about 31 GHz and obtain third harmonic if the interaction region is maintained at high gas pressure. It is desirable to use a gas such as methylene chloride because it is relatively inert. Since the other gases have many more energy levels, more evaluation is required to determine whether the proper energy levels exists for the four-level system.

A vacuum system as shown in Figure 3 was fabricated for testing the corrosive properties of gases. The vacuum system includes a manifold with pressure gauges, a cold trap, and a dry trap to prevent explosive gaseous materials from entering the pump and reacting with the pump oil. All metal parts are nickel or nickel plated to resist corrosion from the gas. Bourdon gauges are used to indicate pressure and vacuum. Various gases will be evaluated in the vacuum system next quarter.

C. SOLID STATE STUDIES

Multiple quantum effects in solids have not been exploited very thoroughly, although they have been observed in ruby (Reference 37) and in MgO(Mn) (Reference 38). In ruby, Smith observed second harmonic generation at 19 GHz. In MgO(Mn), Sorokin found additional lines at high input power because of multiple photon absorption associated with the hyperfine structure. Solid materials could offer many advantages over gases for use in harmonic generation and mixing in the millimeter and submillimeter wavelength regions. This is possible because of the potentially high concentration of nonlinear elements and ease of handling. To take advantage of this, a higher filling factor must be obtained by better cavity design. In many solid materials, ruby for example, there are several operating points occurring for various values of ω, the pumping frequency. These arise from denominators with such terms as:

$$\frac{1}{(\omega_{31} - 2\omega)(\omega_{21} - \omega)(\omega_{32} - \omega)}$$

where the ω_{31}, ω_{32}, ω_{21} are resonances of ruby.

13
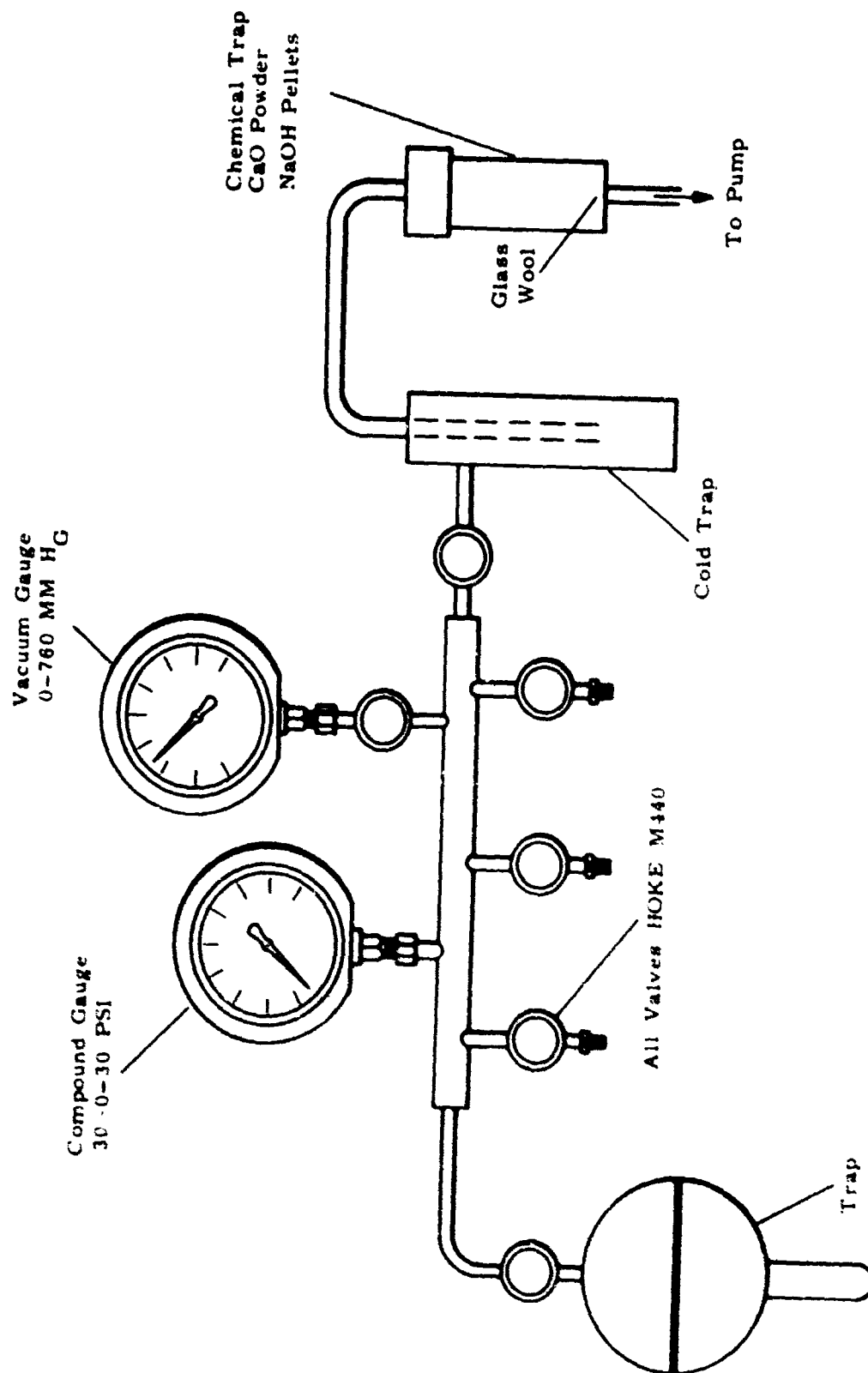
Figure 3. Monel - Nickel Vacuum Manifold

14

Materials with higher zero field splittings and faster spin-lattice relaxation times are under investigation for possible multiple quantum effects. The only experimental work performed in this quarter was devoted to the revision of the microwave bridge to work with the new superconducting magnet. A preliminary run has been successfully made, testing $MgO(Mn)$ up to 53,000 gauss. The multiple quantum effects previously seen at low fields (10,000 gauss) were observed again, showing that the magnet was sufficiently uniform. No new multiple quantum absorptions were found, probably because helium bubbling prevented the use of high power. Preparations are being made to pump the liquid helium to prevent bubbling.

III. EXPERIMENTAL EFFORT DURING FOURTH QUARTER

Experimental effort during the fourth quarter was concerned with two-level partly resonant experiments and parallel plate interferometer experiments.

Problems investigated in the partly resonant experiments are as follows:

<u>1</u> Microwave window

<u>2</u> Use of fluoroform and ammonia gases

<u>3</u> Initial test on SFD Model 327 magnetron

<u>4</u> Use of OKI Laddertron for high power source

<u>5</u> Test of low pass filter with 40 GHz cutoff frequency to suppress magnetron third harmonic.

A. TWO-LEVEL PARTLY RESONANT EXPERIMENTS

During the third quarter of the contract, the difficulty of maintaining a microwave window in the waveguide that feeds the magnetron power to the semiconfocal interferometer was discussed. In reviewing, we must remember that methyl fluoride is unstable in a high power field and decomposes forming hydrogen fluoride. The hydrogen fluoride attacks the window material and soldered flanges. The window is decomposed, and the solder forms a hard deposit on the interior of the waveguide.

To overcome the problem of the gas reacting with the soldered flanges, the interior section of the waveguide between the window and the iris was nickel plated. After several tests with methyl fluoride, visual inspection indicated no further deposits on the interior of the waveguide.

Since the purchased microwave window failed and several windows made from teflon, mica, etc., did not work, it was decided to fabricate several microwave windows from fused quartz and sapphire. The fused quartz was ground to a resonant shape and cemented into a metal window

17

flange. Several tests were run on this window in the interferometer, using ammonia gas. No deterioration of the window was observed after several tests. Unfortunately, the window failed mechanically and it was decided to fabricate a sapphire window. Although the first piece of sapphire was thicker than specified, the decision was made to mount the sapphire in a metal flange and test it. The sapphire was cemented in the metal flange and checked at 35 GHz for insertion loss. The insertion loss was 3 dB. The high insertion loss could be attributed to the nonuniform thickness of the sapphire or to the epoxy cement. A thinner sapphire window (approximately 0.008 inch thick) was fabricated and cemented to the metal flange with a minimum epoxy cement. The insertion loss was less than 1 dB. Several tests were run with this window installed. In one test, the methyl fluoride ionized and deposited a brown substance on the sapphire. When this substance was removed, the sapphire was intact. There was no evidence of the gas reacting with the sapphire surface. Sapphire or alumina windows appear to be best suited for high power application in a corrosive gaseous environment.

In the next series of experiments, fluoroform and ammonia gases were used. Ammonia has many energy levels between 10 and 40 GHz. According to Smith (Reference 28), it should be possible to pump at a frequency near a natural transition frequency and generate third harmonic of this frequency. The efficiency of this mode of operation is not as high as pumping at approximately one third the natural transition frequency. For this test, magnetron power at approximately 34.8 GHz was applied with the output structure tuned to detect 105 GHz. The results of this test were negative. An advantage of using ammonia is its stability and the fact that it did not cause window problems. A disadvantage in the use of ammonia is its reaction with the brass interferometer plates.

The next experiment was with fluoroform gas, a freon manufactured by Dupont. This gas is stable up to 1150°C and very inert chemically. Since it has a natural transition near 100 GHz, the mode of operation is the same as methyl fluoride. No third harmonic was observed in this experiment. This gas appears to be very inert when radiated with a high power microwave field and no harmful effects on the microwave window or other plumbing were observed.

There are several problems associated with the Microwave Associates' Model 206 magnetron that limits its use to multiple quantum investigations. It has fixed frequency and fixed pulse width operation. The magnetron generates high level third harmonic, and the power output is limited to approximately 20 kW. Also, the frequency spectrum as observed on a spectrum analyzer is highly distorted and does not approach the ideal $(\sin \omega)/\omega$. For these reasons, Martin Company decided to purchase a

Model 327 magnetron from SFD Laboratory to be used on multiple quantum and other research projects. This magnetron has a peak power output capability of 180 kW. The pulse width is variable from 0.5 μs to 2.0 μs and the frequency is variable between approximately 34 GHz and 36 GHz. Initial tests were performed to verify the tube operation. An output power of 110 kW was obtained with the tube working into a matched load as shown in Figure 4. In a further test, the waveguide was terminated in a short circuit to determine how effectively the circulator protects the tube. The tube operated satisfactorily in the short circuit condition. For the high power application (above 30 kW), it is necessary to pressurize the rectangular waveguide with approximately 20 pounds of dry nitrogen. Pressurization was no problem since the magnetron output contains a microwave window and the cavity window contains the gas. A partly resonant two-level experiment using this magnetron will be run in the near future.

The next series of experiments was an attempt to use the OKI Laddertron to drive the resonant cavity. The Laddertron has an output of approximately 15 watts at 34.8 GHz and is tunable over a narrow passband. The power level is low enough to prevent window problems, but enough power is available to generate third harmonic according to Smith (Reference 28). Unfortunately, the Laddertron cannot be effectively modulated by the power supply. It was decided to power modulate the output in a ferrite modulator to overcome this problem. In this device, the electromagnetic wave is transmitted through a section of circular cross section ferrite. When a magnetic field is applied to the ferrite, the polarization of the wave is changed and no power is coupled to the output waveguide. With no magnetic field applied, the field couples through the modulator with very low loss. It was possible with this device to obtain an insertion loss of less than 1 dB with no magnetic field applied. Transmission with the field applied was down 15 dB. A two-level partly resonant experiment was run with the Laddertron and Modulator shown in Figure 5, but no third harmonic was obtained. If the cavity and waveguide system can be optimized at a higher power level it should be possible to obtain third harmonic with the Laddertron source.

To suppress the third harmonic content of the Microwave Associates' magnetron, the low pass filter shown in Figure 6 was designed. This filter replaced the filter discussed in the third quarterly report. Further testing verified that the cutoff frequency of the original filter was too low. The revised filter had a higher cutoff frequency with less than 1 dB loss at the operating frequency of 34.8 GHz, but the third harmonic rejection was only 13 dB. Filters of this type have a limited upper frequency range. According to Young, et al (Reference 39), the incoming wave beams to the output with no tight coupling to the waveguide walls, at millimeter frequencies. This effect limits the obtainable harmonic rejection.

19

Figure 4. Magnetron Test Setup
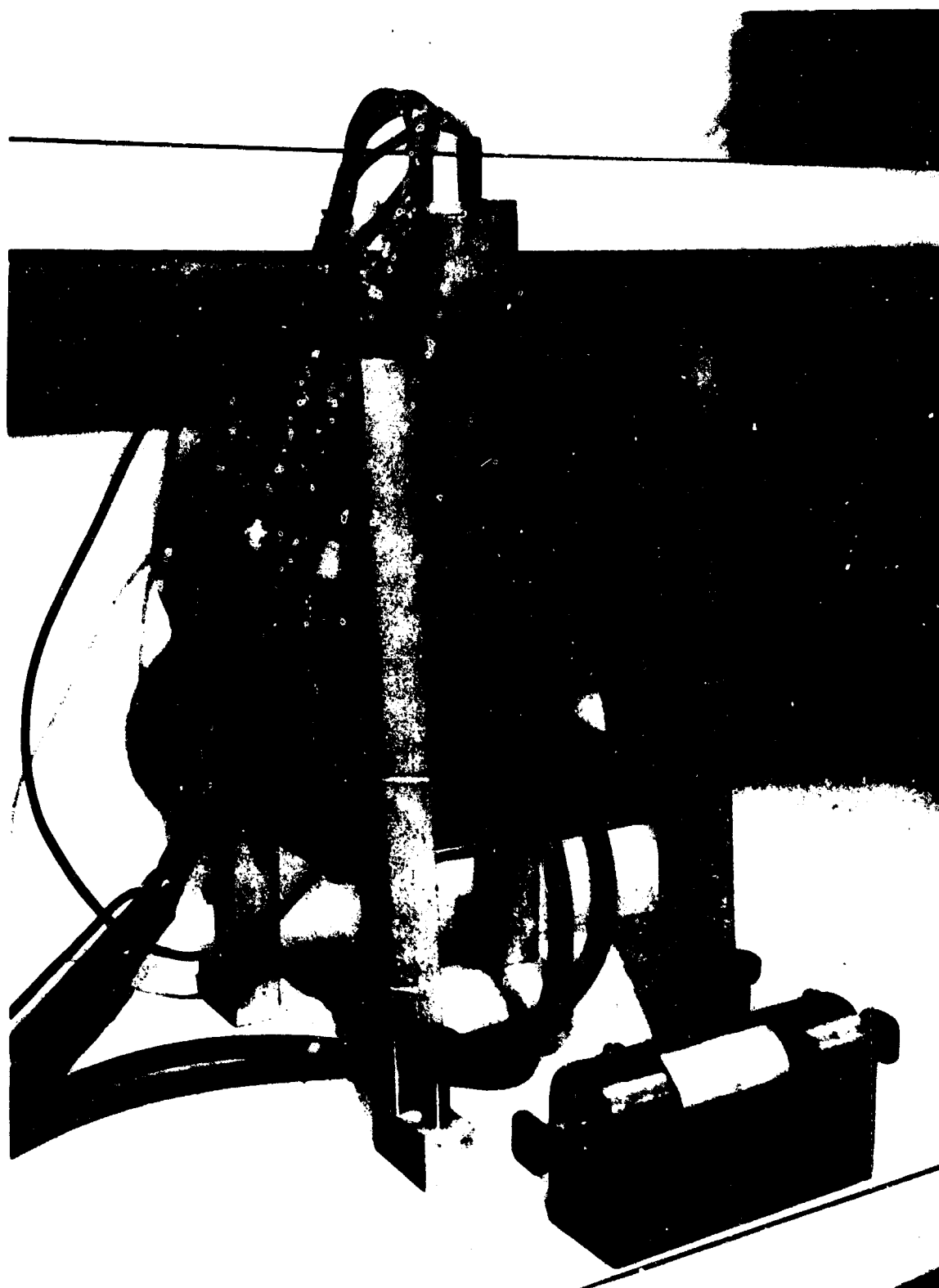
Figure 5. Laddertron Modulator Microwave Source
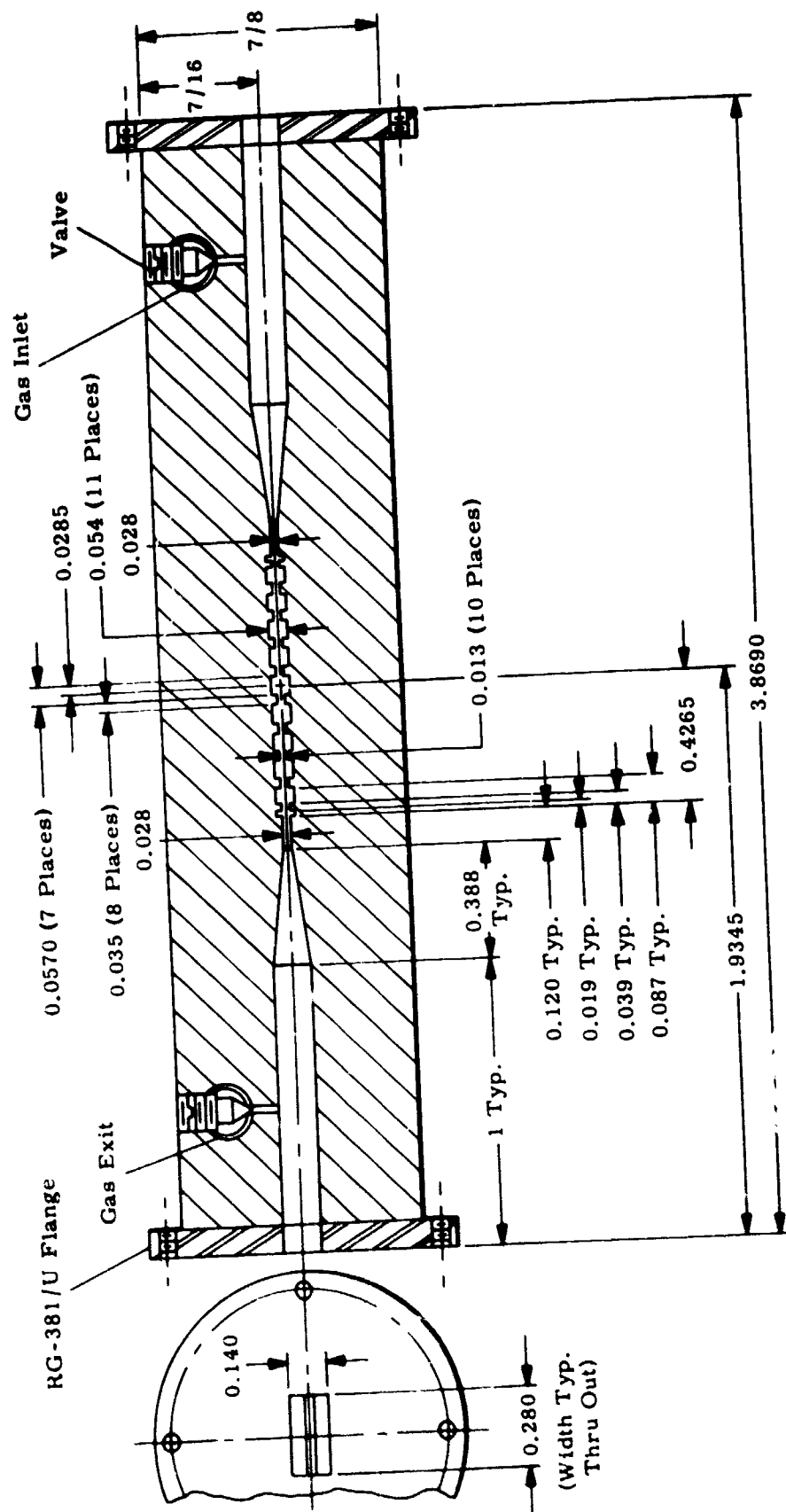
Figure 6. Low Pass Filter

22

B. MULTI-LEVEL TOTALLY RESONANT EXPERIMENTS

The totally resonant experiments consisted in construction and testing of parallel plate interferometers and beam splitters. A vacuum system (Figure 3) was also fabricated to test corrosive gases, but has not yet been used. Figure 7 shows the high frequency parallel plate interferometer operated at 120 GHz. The resonator plates are made by electroforming nickel to 0.001 inch thickness and by gold plating the nickel. The interferometer was tested for Q value and transmission loss before the beam splitter was installed. The Q value at 120 GHz was 9000 and the transmission loss was 12 dB. Careful alignment of all components was necessary to obtain satisfactory operation. A beam splitter was then added between the parallel plates. The support housing for the dielectric sheet allows the angle to be varied in both the vertical and horizontal direction. Various thicknesses of mylar and mica were tried. A sheet of mica 0.002 inch thick allowed transmission with the sheet normal to the direction of the wave front, but alignment was very difficult. To obtain an output signal required difficult adjustment of the support structure. It is suspected that the mica surface is too uneven to be useful for beam splitting.

Several pieces of mylar were also tried in the beam splitter. Adjustment was easier and it was possible to obtain beam splitting with a 0.002 inch thick piece of mylar at an angle of a few degrees to the wave normal. Work on the high frequency beam splitter will continue. The supporting structure will be changed to stretch the dielectric in a radial direction similar to the interferometer plates.

The low frequency interferometer shown in Figure 8 was assembled and is being tested. This interferometer has a Q value of 10,000 at a frequency of 40 GHz with a resonant transmission loss of 13 dB. A beam splitter to couple energy out of this interferometer was designed and is under construction.

The Q values that were obtained for the interferometers are low. However, it must be remembered that all of the fabrication techniques are new. Further experimentation is necessary in the areas of nickel electroforming, gold plating, and support ring design. It is believed that fabrication improvements will be realized in the future. A new gold plating electroforming bath has been added to the plating facilities.
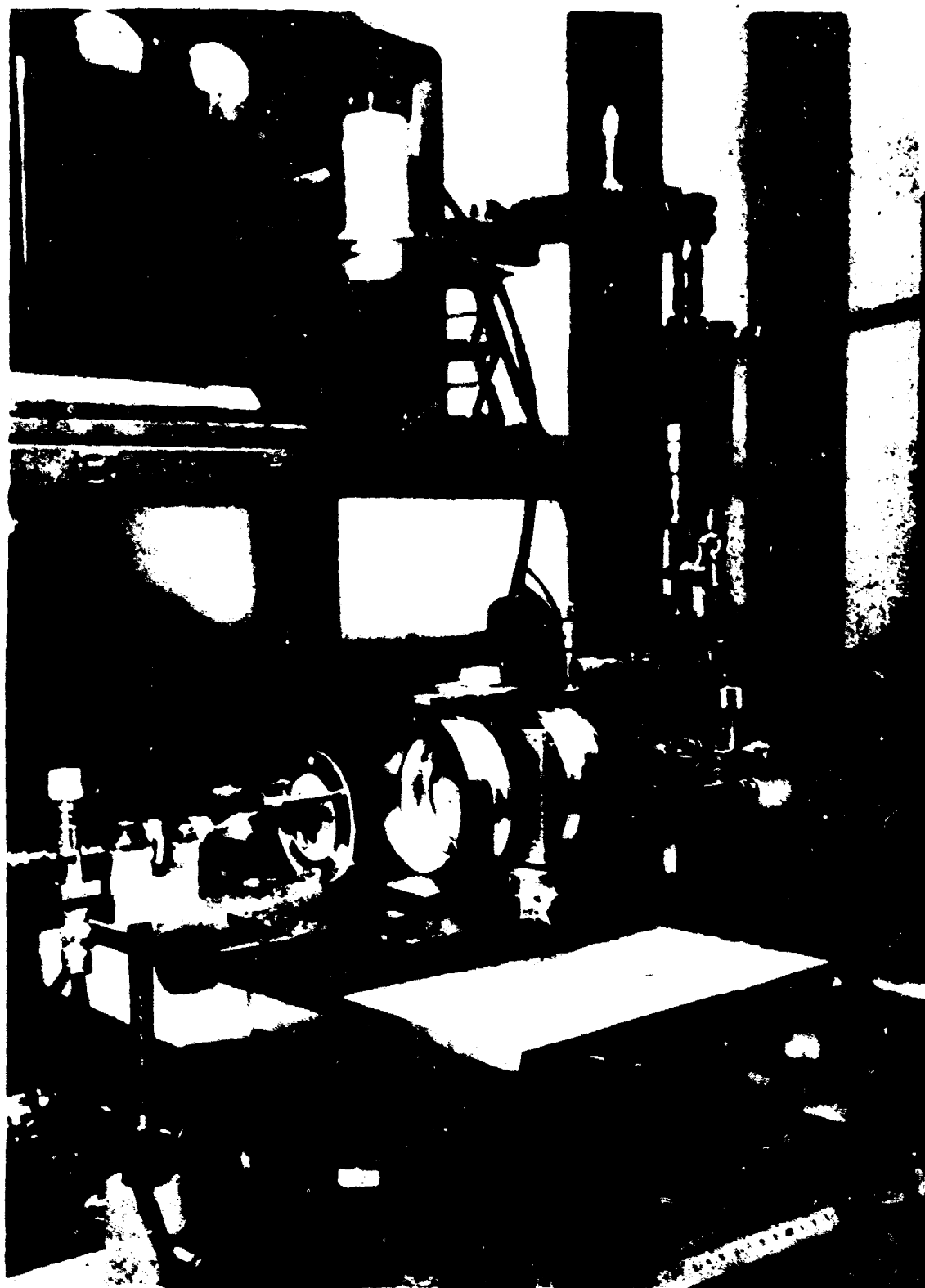
Figure 7. 120 GHz Parallel Plate Interferometer Test Setup
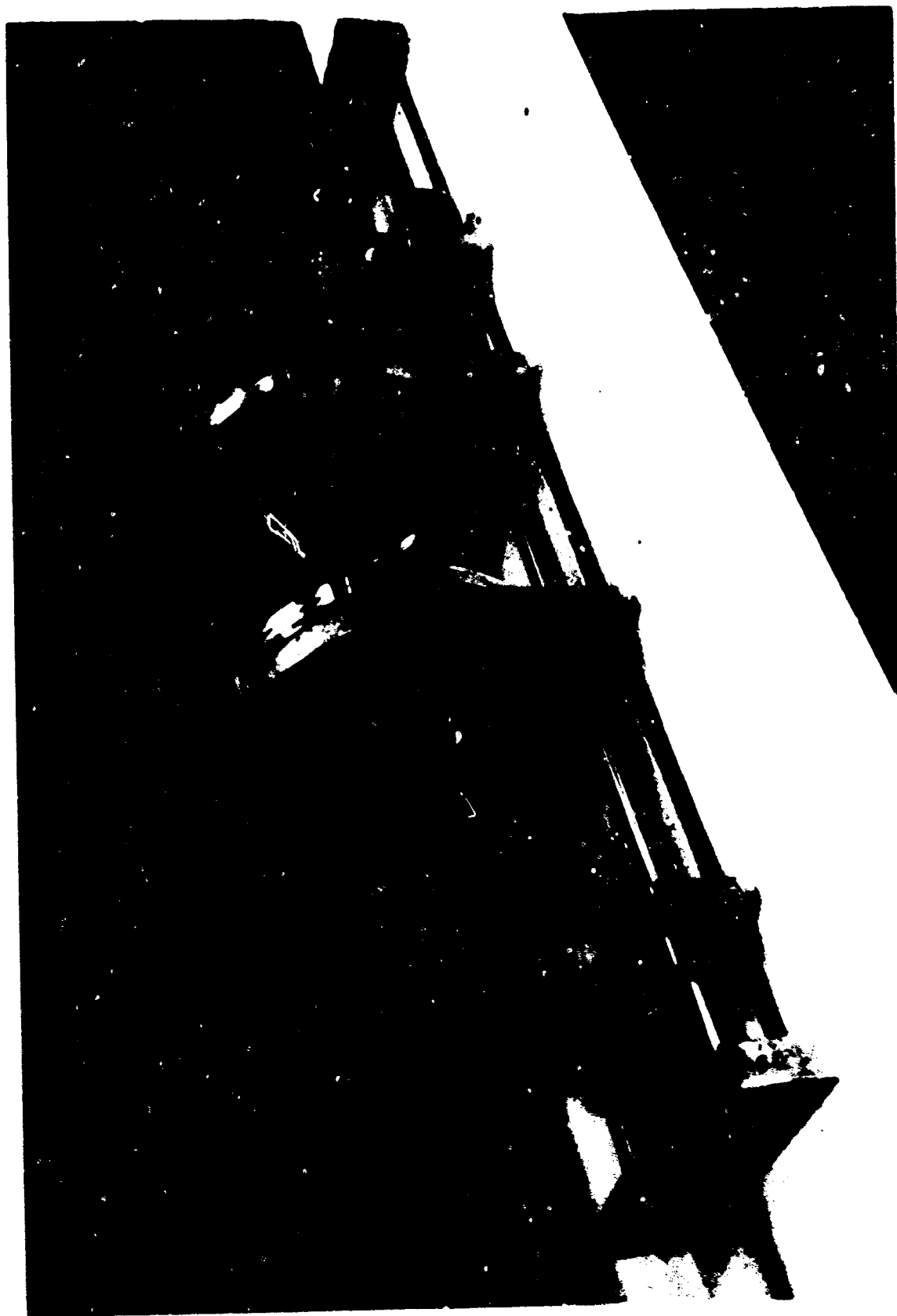
Figure 8. Low Frequency Parallel Plate Interferometer

IV. CONCLUSION

A thin metal strip and a dielectric sheet beam splitter have been designed. Fabrication and mechanical mounting of a metal strip beam splitter is more difficult than a dielectric sheet beam splitter. Therefore, the experimental effort has been directed toward the use of the dielectric sheet design. Demonstrations have proven that it is possible to operate a high Q interferometer with a beam splitter in the interaction region. A study of asymmetric top gases indicate that one of the more stable gases should be used for the totally resonant pumping scheme as these gases present no serious handling problems. The use of methyl fluoride for the two-level system is limited because the gas decomposes in the high energy field. This gas will be replaced by fluoroform which is more inert and has approximately the same transition frequencies and dipole moments as methyl fluoride.

V. PROGRAM FOR NEXT QUARTER

Design and construction will continue on the most promising types of beam splitters. An attempt will be made to select the beam splitter best suited for operation in the multiple resonant interferometer. The energy levels of several asymmetric top gases will be studied to determine appropriate pumping schemes. The experiments to determine the corrosive properties of gases will be completed. The design of several microwave cavities will also be completed. Partly resonant two-level experiments will be run with the new magnetron. In addition to methyl fluoride, several other symmetric top gases will be tried. Nonlinear quantum effects in solids will be studied. Tests of ruby, emerald, and MgO (Mn) will be made to determine suitable sets of transitions.

VI. KEY PERSONNEL

With Dr. V. E. Derr acting as task leader without charge to the contract, the manpower charges for the fourth quarter are as follows:

G. W. Bechtold	152.0
Engineering Aid	80.0
Presentations	43.0
Model Shop	275.0

APPENDIX A

RIGID ROTOR ENERGY LEVELS FOR
SEVERAL ASYMMETRIC TOP GASES

APPENDIX A

This appendix gives the energy levels for several asymmetric top gases. The energy levels are computed according to the following equation:

$$W/h = \tfrac{1}{2}(A+C) \, J \, (J+1) + \tfrac{1}{2}(A-C) \, E(\tau)$$

where

W/h is in Hz

A and C are rotational constants

$E(\tau)$ is the reduced energy

J is the total angular momentum.

The suffix numbers in these computer runs for the Input Coefficients, the Rigid Rotor, and the Nu Calculated values indicate the number of places to move the decimal point to the right.

METHYLENE FLUORIDE RIGID ROTOR
TRANSITION FREQUENCIES

Input Coefficients

$\mu_a = 0$

A = 0.4913840DF 05

B = 0.1060389DE 05 $\mu_b = 1.96$ K = -0.932077

C = 0.9249200DF 04

$\mu_c = 0$

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
1	1_{11} 0	-0	0_{00} 0	0.5838763DCE 05	0.58387600E 05	0.
1	1_{10} 1	1	1_{01} -1	0.3988920DE 05	0.39889200E 05	0.
2	2_{02} -2	1	1_{11} 0	0.11365757F 04	0.11365767E 04	0.
2	2_{12} -1	1	1_{01} -1	0.76885999E 05	0.76885999E 05	0.
2	2_{21} 1	1	1_{10} 1	0.15566440F 06	0.15666440E 06	0.
2	2_{20} 2	1	1_{11} 0	0.15805418E 06	0.15805418E 06	0.
2	2_{11} 0	2	2_{02} -2	0.41278983E 05	0.41273983E 05	0.
2	2_{21} 1	2	2_{12} -1	0.11966750F 06	0.11966760E 06	0.
2	2_{20} 2	2	2_{11} 0	0.11563852F 05	0.11563862E 06	0.
3	3_{03} -3	2	2_{12} -1	0.22204139E 05	0.22204139E 05	0.
3	3_{13} -2	2	2_{02} -2	0.94720492F 05	0.94720492E 05	0.
3	3_{13} -2	2	2_{20} 2	-0.62197114E 05	-0.62197114E 05	0.
3	3_{12} -1	2	2_{21} 1	-0.54034448E 05	-0.54034848E 05	0.
3	3_{22} 0	2	2_{11} 0	0.17516280E 06	0.17516280E 06	0.
3	3_{21} 1	2	2_{12} -1	0.17940218F 06	0.17940218E 06	0.
3	3_{31} 2	2	2_{02} -2	0.41252271E 06	0.41252271E 06	0.
3	3_{31} 2	2	2_{20} 2	0.25560510E 06	0.25560510E 06	0.
3	3_{30} 3	2	2_{21} 1	0.25564076E 06	0.25564076E 06	0.
3	3_{12} -1	3	3_{03} -3	0.43429012E 05	0.43429012E 05	0.
3	3_{22} 0	3	3_{13} -2	0.12172129E 06	0.12172129E 06	0.
3	3_{21} 1	3	3_{12} -1	0.11376903F 06	0.11376903E 06	0.
3	3_{31} 2	3	3_{22} 0	0.19608093F 06	0.19608093E 06	0.
3	3_{30} 3	3	3_{03} -3	0.35310422F 06	0.35310422F 06	0.
3	3_{30} 3	3	3_{21} 1	0.19590618E 06	0.19590618E 06	0.
4	4_{04} -4	3	3_{12} -2	0.43761401F 05	0.43761401E 05	0.
4	4_{04} -4	3	3_{31} 2	-0.27404081E 06	-0.27404081E 06	0.
4	4_{14} -3	3	3_{03} -3	0.11193591E 06	0.11193591E 06	0.
4	4_{14} -3	3	3_{21} 1	-0.45262131E 05	-0.45262131E 05	0.
4	4_{13} -2	3	3_{22} 0	-0.31543897E 05	-0.31543897E 05	0.
4	4_{23} -1	3	3_{12} -1	0.19297878F 06	0.19297878E 06	0.
4	4_{23} -1	3	3_{30} 3	-0.11569643E 06	-0.11669643E 06	0.
4	4_{22} 0	3	3_{13} -2	0.20163118E 06	0.20163118E 06	0.
4	4_{22} 0	3	3_{31} 2	-0.11517134E 06	-0.11617134E 06	0.
4	4_{32} 1	3	3_{03} -3	0.43258453F 06	0.43258453E 06	0.
4	4_{32} 1	3	3_{21} 1	0.27538449E 06	0.27538649E 06	0.
4	4_{31} 2	3	3_{22} 0	0.27555578F 06	0.27555578E 06	0.

36

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
4	4 4_1 3	3	3_{12} -1	0.56357563E 06	0.66357563E 06	0.
4	4 4_1 3	3	3_{30} 3	0.35390042F 06	0.35390042E 06	0.
4	4 40 4	3	3_{13} -2	0.67170322E 06	0.67170322E 06	0.
4	4 40 4	3	3 3_1 2	0.35390100F 06	0.35390100E 06	0.
4	4 13 -2	4	4_{04} -4	0.46415992E 05	0.46415992E 05	0.
4	4 2_3 -1	4	4_{14} -3	0.12447198F 06	0.12447188F 06	0.
4	4 2_2 0	4	4_{13} -2	0.11145378E 06	0.11145378E 06	0.
4	4 3_2 1	4	4_{23} -1	0.19617674E 06	0.19617674E 06	0.
4	4 3_1 2	4	4_{04} -4	0.35352566F 06	0.35352566E 06	0.
4	4 3_1 2	4	4_{22} 0	0.19565589E 06	0.19565589E 06	0.
4	4 4_1 3	4	4_{14} -3	0.59506873E 06	0.59505873F 06	0.
4	4 4_1 3	4	4 3_2 1	0.27442012E 06	0.27442012E 06	0.
4	4 40 4	4	4_{13} -2	0.58152582E 06	0.58152582E 06	0.
4	4 40 4	4	4 3_1 2	0.27441615F 06	0.27441615E 06	0.
5	5 0_5 -5	4	4_{14} -3	0.55597536E 05	0.65697536E 05	0.
5	5 0_5 -5	4	4_{32} 1	-0.25495108E 06	-0.25495108E 06	0.
5	5 1_5 -4	4	4_{04} -4	0.12860412F 06	0.12860412E 06	0.
5	5 1_5 -4	4	4_{22} 0	-0.29265658E 05	-0.29265658E 05	0.
5	5 1_6 -4	4	4_{40} 4	-0.49933770E 06	-0.49933770E 06	0.
5	5 1_4 -3	4	4_{23} -1	-0.84363806F 04	-0.84363806E 04	0.
5	5 1_4 -3	4	4_{41} 3	-0.47903324F 06	-0.47903324E 06	0.
5	5 2_4 -2	4	4_{13} -2	0.21011643E 06	0.21011643E 06	0.
5	5 2_4 -2	4	4_{31} 2	-0.96993244E 05	-0.96993244E 05	0.
5	5 2_3 -1	4	4_{14} -3	0.22487896E 06	0.22487896E 06	0.
5	5 2_3 -1	4	4_{32} 1	-0.95769650E 05	-0.95769660E 05	0.
5	5 3_3 0	4	4_{04} -4	0.45290190E 06	0.45290190E 06	0.
5	5 3_3 0	4	4_{22} 0	0.29503212E 06	0.29503212E 06	0.
5	5 3_3 0	4	4_{40} 4	-0.17503991E 06	-0.17503991E 06	0.
5	5 3_2 1	4	4_{23} -1	0.29557285E 06	0.29557285E 06	0.
5	5 3_2 1	4	4_{41} 3	-0.17502401E 06	-0.17502401F 06	0.
5	5 4_2 2	4	4_{13} -2	0.68086924F 06	0.68086724E 06	0.
5	5 4_2 2	4	4_{31} 2	0.37375957E 06	0.37375957E 06	0.
5	5 4_1 3	4	4_{14} -3	0.69441223E 06	0.69441223E 06	0.
5	5 4_1 3	4	4_{32} 1	0.37376362F 06	0.37376362E 06	0.
5	5 5_1 4	4	4_{04} -4	0.10901195E 07	0.10801195E 07	0.
5	5 5_1 4	4	4_{22} 0	0.92224978E 06	0.92224978E 06	0.
5	5 5_1 4	4	4_{40} 4	0.45217774E 06	0.45217774E 06	0.
5	5 50 5	4	4_{23} -1	0.92277450E 06	0.92277460E 06	0.
5	5 50 5	4	4_{41} 3	0.45217775E 06	0.45217775E 06	0.
5	5 1_4 -3	5	5_{05} -5	0.50337966E 05	0.50337966E 05	0.
5	5 2_4 -2	5	5_{15} -4	0.12792830F 06	0.12792830E 06	0.
5	5 2_3 -1	5	5_{14} -3	0.10884346E 06	0.10884346E 06	0.
5	5 3_3 0	5	5_{24} -2	0.19636948E 06	0.19636948E 06	0.
5	5 3_2 1	5	5_{05} -5	0.35434720E 06	0.35434720E 06	0.
5	5 3_2 1	5	5_{23} -1	0.19516577E 06	0.19515577E 06	0.
5	5 4_2 2	5	5_{15} -4	0.59868112F 06	0.59868112E 06	0.
5	5 4_2 2	5	5_{33} 0	0.27438334E 06	0.27438334E 06	0.
5	5 4_1 3	5	5_{14} -3	0.57837673E 06	0.57837673E 06	0.
5	5 4_1 3	5	5_{32} 1	0.27436750E 06	0.27436750E 06	0.
5	5 5_1 4	5	5_{24} -2	0.82358713E 06	0.82358713E 06	0.
5	5 5_1 4	5	5_{42} 2	0.35283432F 06	0.35283432E 06	0.
5	5 50 5	5	5_{05} -5	0.98154895E 06	0.98154895E 06	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
5	550 5	5	523 -1	0.82236752E 06	0.82236752E 06	0.
5	550 5	5	541 3	0.35283425E 06	0.35283425E 06	0.
6	606 -6	5	515 -4	0.87881994E 05	0.87881994E 05	0.
6	606 -6	5	533 0	-0.23641579E 06	-0.23641579E 06	0.
6	606 -6	5	551 4	-0.86363345E 06	-0.86363345E 06	0.
6	616 -5	5	505 -5	0.14482280E 06	0.14482280E 06	0.
6	616 -5	5	523 -1	-0.14358627E 05	-0.14358627E 05	0.
6	616 -5	5	541 3	-0.48389190E 06	-0.48389190E 06	0.
6	615 -4	5	524 -2	0.15261836E 05	0.15261836E 05	0.
6	615 -4	5	542 2	-0.45549098E 06	-0.45549098E 06	0.
6	625 -3	5	514 -3	0.22658455E 06	0.22658455E 06	0.
6	625 -3	5	532 1	-0.77424682E 05	-0.77424682E 05	0.
6	625 -3	5	550 5	-0.70462644E 06	-0.70462644E 06	0.
6	624 -2	5	515 -4	0.24931137E 06	0.24931137E 06	0.
6	624 -2	5	533 0	-0.74986417E 05	-0.74986417E 05	0.
6	624 -2	5	551 4	-0.70220407E 06	-0.70220407E 06	0.
6	634 -1	5	505 -5	0.47362727E 06	0.47362727E 06	0.
6	634 -1	5	523 -1	0.31444584E 06	0.31444584E 06	0.
6	634 -1	5	541 3	-0.15508743E 06	-0.15508743E 06	0.
6	633 0	5	524 -2	0.31571308E 06	0.31571308E 06	0.
6	633 0	5	542 2	-0.15503973E 06	-0.15503973E 06	0.
6	643 1	5	514 -3	0.69761444E 06	0.69761444E 06	0.
6	643 1	5	532 1	0.39360521E 06	0.39360521E 06	0.
6	643 1	5	550 5	-0.23359654E 06	-0.23359654E 06	0.
6	642 2	5	515 -4	0.71791923E 06	0.71791923E 06	0.
6	642 2	5	533 0	0.39362145E 06	0.39362145E 06	0.
6	642 2	5	551 4	-0.23359620E 06	-0.23359620E 06	0.
6	652 3	5	505 -5	0.11007552E 07	0.11007552E 07	0.
6	652 3	5	523 -1	0.94157383E 06	0.94157383E 06	0.
6	652 3	5	541 3	0.47204055E 06	0.47204055E 06	0.
6	651 4	5	524 -2	0.94279344E 06	0.94279344E 06	0.
6	651 4	5	542 2	0.47204052E 06	0.47204052E 06	0.
6	661 5	5	514 -3	0.14816656E 07	0.14816656E 07	0.
6	661 5	5	532 1	0.11776564E 07	0.11776564E 07	0.
6	661 5	5	550 5	0.55045453E 06	0.55045453E 06	0.
6	660 6	5	515 -4	0.15019701E 07	0.15019701E 07	0.
6	660 6	5	533 0	0.11776723E 07	0.11776723E 07	0.
6	660 6	5	551 4	0.55045463E 06	0.55045463E 06	0.
6	615 -4	6	606 -6	0.55308145E 05	0.55308145E 05	0.
6	625 -3	6	616 -5	0.13209971E 06	0.13209971E 06	0.
6	624 -2	6	615 -4	0.10512123E 06	0.10512123E 06	0.
6	634 -1	6	625 -3	0.19570475E 06	0.19570475E 06	0.
6	633 0	6	606 -6	0.35575939E 06	0.35575939E 06	0.
6	633 0	6	624 -2	0.19433302E 06	0.19433302E 05	0.
6	643 1	6	616 -5	0.60312961E 06	0.60312961E 06	0.
6	643 1	6	634 -1	0.27432514E 06	0.27432514E 06	0.
6	642 2	6	615 -4	0.57472909E 06	0.57472909E 06	0.
6	642 2	6	633 0	0.27427795E 06	0.27427795E 06	0.
6	652 3	6	625 -3	0.82383274E 06	0.82383274E 06	0.
6	652 3	6	643 1	0.35280285E 06	0.35280285E 06	0.
6	651 4	6	606 -6	0.98283975E 06	0.98283975E 06	0.
6	651 4	6	624 -2	0.82141037E 06	0.82141037E 06	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
6	651 4	6	642 2	0.35280250F 06	0.35280250E 06	0.
6	661 5	6	616 -5	0.13971808F 07	0.13971808E 07	0.
6	661 5	6	634 -1	0.10583753E 07	0.10583763E 07	0.
6	661 5	6	652 3	0.43124833E 06	0.43124833E 06	0.
6	660 6	6	615 -4	0.13587799E 07	0.13587799E 07	0.
6	660 6	6	633 0	0.10583287E 07	0.10583287F 07	0.
6	660 6	6	651 4	0.43124833E 06	0.43124833E 06	0.
7	707 -7	6	615 -5	0.11017200E 06	0.11017200E 06	0.
7	707 -7	6	634 -1	-0.21863247E 06	-0.21863247E 06	0.
7	707 -7	6	652 3	-0.84576045E 06	-0.84576045E 06	0.
7	717 -6	6	606 -6	0.16071156F 06	0.16071166E 06	0.
7	717 -6	6	624 -2	-0.71771251E 03	-0.71771251E 03	0.
7	717 -6	6	642 2	-0.46932558E 06	-0.46932559E 06	0.
7	717 -6	6	660 6	-0.12533764F 07	-0.12533764AE 07	0.
7	716 -5	6	625 -3	0.39517125E 05	0.39517125E 05	0.
7	716 -5	6	643 1	-0.43151277E 06	-0.43151277E 06	0.
7	716 -5	6	661 5	-0.12155640E 07	-0.12155640E 07	0.
7	726 -4	6	615 -4	0.24239786E 06	0.24239786E 06	0.
7	726 -4	6	633 0	-0.58053389E 05	-0.58053389E 05	0.
7	726 -4	6	651 4	-0.68513374E 06	-0.68513374E 06	0.
7	725 -3	6	616 -5	0.27511250E 06	0.27511250E 06	0.
7	725 -3	6	634 -1	-0.53691964E 05	-0.53691964E 05	0.
7	725 -3	6	652 3	-0.68081995E 06	-0.68081995E 06	0.
7	735 -2	6	606 -6	0.49494029F 06	0.49494029E 06	0.
7	735 -2	6	624 -2	0.33351092E 06	0.33351092E 06	0.
7	735 -2	6	642 2	-0.13509695F 06	-0.13509695E 06	0.
7	735 -2	6	660 6	-0.91914779E 06	-0.91914779E 06	0.
7	734 -1	6	625 -3	0.33505213F 06	0.33605213E 06	0.
7	734 -1	6	643 1	-0.13497776E 06	-0.13497776E 06	0.
7	734 -1	6	661 5	-0.91902894E 06	-0.91902894E 06	0.
7	744 0	6	615 -4	0.71387472E 06	0.71387472E 06	0.
7	744 0	6	633 0	0.41342348E 06	0.41342348E 06	0.
7	744 0	6	651 4	-0.21365688E 06	-0.21365688E 06	0.
7	743 1	6	616 -5	0.74227684E 06	0.74227684E 06	0.
7	743 1	6	634 -1	0.41347237E 06	0.41347237E 06	0.
7	743 1	6	652 3	-0.21365552E 06	-0.21365562E 06	0.
7	753 2	6	606 -6	0.11219360F 07	0.11219360E 07	0.
7	753 2	6	624 -2	0.96050659F 06	0.96050658E 06	0.
7	753 2	6	642 2	0.49189871E 06	0.49189871E 06	0.
7	753 2	6	660 6	-0.29215212E 06	-0.29215212E 06	0.
7	752 3	6	625 -3	0.96292895E 06	0.96292895E 06	0.
7	752 3	6	643 1	0.49189906E 06	0.49189906E 06	0.
7	752 3	6	661 5	-0.29215212E 06	-0.29215212E 06	0.
7	762 4	6	615 -4	0.14978499E 07	0.14978499E 07	0.
7	762 4	6	633 0	0.11973986E 07	0.11973986E 07	0.
7	762 4	6	651 4	0.57031825E 06	0.57031825E 06	0.
7	761 5	6	616 -5	0.15262507E 07	0.15262507E 07	0.
7	761 5	6	634 -1	0.11974452E 07	0.11974462E 07	0.
7	761 5	6	652 3	0.57031826F 06	0.57031826E 06	0.
7	771 6	6	606 -6	0.20628196F 07	0.20628196E 07	0.
7	771 6	6	624 -2	0.19013902E 07	0.19013902E 07	0.
7	771 6	6	642 2	0.14327823E 07	0.14327823E 07	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
7	7 7₁ 6	6	6 60 6	0.54873150E 06	0.54873150E 06	0.
7	7 70 7	6	6 25 -3	0.19038126E 07	0.19038126E 07	0.
7	7 70 7	6	6 43 1	0.14327827E 07	0.14327827E 07	0.
7	7 70 7	6	6 61 5	0.54873150E 06	0.54873150E 06	0.
7	7 16 -5	7	7 07 -7	0.61444837E 05	0.61444837E 05	0.
7	7 26 -4	7	7 17 -6	0.13699434E 06	0.13699434E 06	0.
7	7 25 -3	7	7 16 -5	0.10349566E 06	0.10349566E 06	0.
7	7 35 -2	7	7 26 -4	0.19723429E 06	0.19723429E 06	0.
7	7 34 -1	7	7 07 -7	0.35797984E 06	0.35797984E 06	0.
7	7 34 -1	7	7 25 -3	0.19303934E 06	0.19303934E 06	0.
7	7 44 0	7	7 17 -6	0.60847121E 06	0.60847121E 06	0.
7	7 44 0	7	7 35 -2	0.27424257E 06	0.27424257E 06	0.
7	7 43 1	7	7 16 -5	0.57065999E 06	0.57065999E 06	0.
7	7 43 1	7	7 34 -1	0.27412499E 06	0.27412499E 06	0.
7	7 53 2	7	7 26 -4	0.82422995E 06	0.82422995E 06	0.
7	7 53 2	7	7 44 0	0.35275308E 06	0.35275308E 06	0.
7	7 52 3	7	7 67 -7	0.98485666E 06	0.98485666E 06	0.
7	7 52 3	7	7 25 -3	0.81991616E 06	0.81991616E 06	0.
7	7 52 3	7	7 43 1	0.35275183E 06	0.35275183E 06	0.
7	7 62 4	7	7 17 -6	0.13924463E 07	0.13924463E 07	0.
7	7 62 4	7	7 35 -2	0.10582177E 07	0.10582177E 07	0.
7	7 62 4	7	7 53 2	0.43122205E 06	0.43122205E 06	0.
7	7 61 5	7	7 16 -5	0.13546339E 07	0.13546339E 07	0.
7	7 61 5	7	7 34 -1	0.10580989E 07	0.10580989E 07	0.
7	7 61 5	7	7 52 3	0.43122204E 06	0.43122204E 06	0.
7	7 71 6	7	7 26 -4	0.17651136E 07	0.17651136E 07	0.
7	7 71 6	7	7 44 0	0.12936357E 07	0.12936357E 07	0.
7	7 71 6	7	7 62 4	0.50966158E 06	0.50966158E 06	0.
7	7 70 7	7	7 07 -7	0.19257403E 07	0.19257403E 07	0.
7	7 70 7	7	7 25 -3	0.17607998E 07	0.17607998E 07	0.
7	7 70 7	7	7 43 1	0.12936355E 07	0.12936355E 07	0.
7	7 70 7	7	7 61 5	0.50966158E 06	0.50966158E 06	0.
8	8 08 -8	7	7 17 -6	0.13242371E 06	0.13242371E 06	0.
8	8 08 -8	7	7 35 -2	-0.20180492E 06	-0.20180492E 06	0.
8	8 08 -8	7	7 53 2	-0.82880058E 06	-0.82880058E 06	0.
8	8 08 -8	7	7 71 6	-0.17696842E 07	-0.17696842E 07	0.
8	8 18 -7	7	7 07 -7	0.17640530E 06	0.17640530E 06	0.
8	8 18 -7	7	7 25 -3	0.11464803E 05	0.11464803E 05	0.
8	8 18 -7	7	7 43 1	-0.45569953E 06	-0.45569953E 06	0.
8	8 18 -7	7	7 61 5	-0.12396734E 07	-0.12396736E 07	0.
8	8 17 -6	7	7 26 -4	0.64286739E 05	0.64286739E 05	0.
8	8 17 -6	7	7 44 0	-0.40719012E 06	-0.40719012E 06	0.
8	8 17 -6	7	7 62 4	-0.11911652E 07	-0.11911652E 07	0.
8	8 27 -5	7	7 16 -5	0.25757854E 06	0.25757864E 06	0.
8	8 27 -5	7	7 34 -1	-0.38956368E 05	-0.38956368E 05	0.
8	8 27 -5	7	7 52 3	-0.66583319E 06	-0.66583319E 06	0.
8	8 27 -5	7	7 70 7	-0.16067168E 07	-0.16067168E 07	0.
8	8 26 -4	7	7 17 -6	0.30247104E 06	0.30247104E 06	0.
8	8 26 -4	7	7 35 -2	-0.31757593E 05	-0.31757593E 05	0.
8	8 26 -4	7	7 53 2	-0.65875325E 06	-0.65875325E 06	0.
8	8 26 -4	7	7 71 6	-0.15996369E 07	-0.15996369E 07	0.
8	8 36 -3	7	7 07 -7	0.51703791E 06	0.51703791E 06	0.

40

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
8	8 36 -3	7	7 25 -3	0.35209741E 06	0.35209741E 06	0.
8	8 36 -3	7	7 43 1	-0.11506672E 06	-0.11506672E 06	0.
8	8 36 -3	7	7 61 5	-0.89904080E 06	-0.89904080E 06	0.
8	8 35 -2	7	7 26 -4	0.35667187E 06	0.35667187E 06	0.
8	8 35 -2	7	7 44 0	-0.11480499E 06	-0.11480499E 06	0.
8	8 35 -2	7	7 62 4	-0.89878012E 06	-0.89878012E 06	0.
8	8 45 -1	7	7 16 -5	0.72972898E 06	0.72972888E 06	0.
8	8 45 -1	7	7 34 -1	0.43319388E 06	0.43319388E 06	0.
8	8 45 -1	7	7 52 3	-0.19368294E 06	-0.19368294E 06	0.
8	8 45 -1	7	7 70 7	-0.11345666E 07	-0.11345666E 07	0.
8	8 44 0	7	7 17 -6	0.76754512E 06	0.76754512E 06	0.
8	8 44 0	7	7 35 -2	0.43331650E 06	0.43331660E 06	0.
8	8 44 0	7	7 53 2	-0.19367916E 06	-0.19367916E 06	0.
8	8 44 0	7	7 71 6	-0.11345623E 07	-0.11345623E 07	0.
8	8 54 1	7	7 07 -7	0.11438530E 07	0.11438530E 07	0.
8	8 54 1	7	7 25 -3	0.97891252E 06	0.97891252E 06	0.
8	8 54 1	7	7 43 1	0.51174819E 06	0.51174819E 06	0.
8	8 54 1	7	7 61 5	-0.27222559E 06	-0.27222569E 06	0.
8	8 53 2	7	7 26 -4	0.98322634E 06	0.98322634E 06	0.
8	8 53 2	7	7 44 0	0.51174947E 06	0.51174947E 06	0.
8	8 53 2	7	7 62 4	-0.27222556E 06	-0.27222556E 06	0.
8	8 63 3	7	7 16 -5	0.15135910E 07	0.15135910E 07	0.
8	8 63 3	7	7 34 -1	0.12170560E 07	0.12170560E 07	0.
8	8 63 3	7	7 52 3	0.59017916E 06	0.59017916E 06	0.
8	8 63 3	7	7 70 7	-0.35070445E 06	-0.35070445E 06	0.
8	8 62 4	7	7 17 -6	0.15514035E 07	0.15514035E 07	0.
8	8 62 4	7	7 35 -2	0.12171748E 07	0.12171748E 07	0.
8	8 62 4	7	7 53 2	0.59017917E 06	0.59017917E 06	0.
8	8 62 4	7	7 71 6	-0.35070445E 06	-0.35070445E 06	0.
8	8 72 5	7	7 07 -7	0.20846742E 07	0.20846742E 07	0.
8	8 72 5	7	7 25 -3	0.19197337E 07	0.19197337E 07	0.
8	8 72 5	7	7 43 1	0.14525694E 07	0.14525694E 07	0.
8	8 72 5	7	7 61 5	0.66859552E 06	0.66859562E 06	0.
8	8 71 6	7	7 26 -4	0.19240475E 07	0.19240475E 07	0.
8	8 71 6	7	7 44 0	0.14525707E 07	0.14525707E 07	0.
8	8 71 6	7	7 62 4	0.66859552E 06	0.66859562E 06	0.
8	8 81 7	7	7 16 -5	0.26113038E 07	0.26113038E 07	0.
8	8 81 7	7	7 34 -1	0.23147698E 07	0.23147688E 07	0.
8	8 81 7	7	7 52 3	0.16878920E 07	0.16878920E 07	0.
8	8 81 7	7	7 70 7	0.74700834E 06	0.74700834E 06	0.
8	8 80 8	7	7 17 -6	0.26491162E 07	0.26491162E 07	0.
8	8 80 8	7	7 35 -2	0.23148876E 07	0.23148876E 07	0.
8	8 80 8	7	7 53 2	0.16878920E 07	0.16878920E 07	0.
8	8 80 8	7	7 71 6	0.74700834E 06	0.74700834E 06	0.
8	8 17 -6	8	8 08 -8	0.68857375E 05	0.68857375E 05	0.
8	8 27 -5	8	8 18 -7	0.14261817E 06	0.14261817E 06	0.
8	8 26 -4	8	8 17 -5	0.10118996E 06	0.10119996E 06	0.
8	8 36 -3	8	8 27 -5	0.19801443E 06	0.19801443E 06	0.
8	8 36 -2	8	8 08 -8	0.36124250E 06	0.36124250E 06	0.
8	8 35 -2	8	8 26 -4	0.19119517E 06	0.19119517E 06	0.
8	8 45 -1	8	8 18 -7	0.61476841E 06	0.61476841E 06	0.
8	8 45 -1	8	8 36 -3	0.27413581E 06	0.27413581E 06	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
8	8 44	0	8 8 17	-6	0.56626404F 06	0.56626404E 06	0.
8	8 44	0	8 935	-2	0.27387831E 06	0.27387831F 06	0.
8	8 54	1	8 827	-5	0.82482955E 06	0.82482955E 06	0.
8	8 54	1	8 845	-1	0.35267930F 06	0.35267930E 06	0.
8	8 53	2	8 808	-8	0.98779697F 06	0.98779697F 06	0.
8	8 53	2	8 826	-4	0.81774954E 06	0.81774954F 06	0.
8	8 53	2	8 844	0	0.35267555F 06	0.35267555E 06	0.
8	8 63	3	8 817	-7	0.13986305F	0.13986305F 07	0.
8	8 63	3	8 836	-3	0.10579979E 07	0.10579979F 07	0.
8	8 63	3	8 854	1	0.43118281F 06	0.43118281E 06	0.
8	8 62	4	8 817	-6	0.13501224E 07	0.13501224F 07	0.
8	8 62	4	8 835	-2	0.10577372E 07	0.10577372E 07	0.
8	8 62	4	8 853	2	0.43118279E 06	0.43118279E 06	0.
8	8 72	5	8 827	-5	0.17556507F 07	0.17656507E 07	0.
8	8 72	5	8 845	-1	0.12935005E 07	0.12935005E 07	0.
8	8 72	5	8 863	3	0.50963940E 06	0.50963840E 06	0.
8	8 71	6	8 808	-8	0.19286182E 07	0.19286182E 07	0.
8	8 71	6	8 826	-4	0.17585708E 07	0.17585708E 07	0.
8	8 71	6	8 844	0	0.12934957E 07	0.12934967E 07	0.
8	8 71	6	8 862	4	0.50963940F 06	0.50963840E 06	0.
8	8 81	7	8 818	-7	0.24963433F 07	0.24963433E 07	0.
8	8 81	7	8 836	-3	0.21557107F 07	0.21557107E 07	0.
8	8 81	7	8 854	1	0.15288956F 07	0.15288956E 07	0.
8	8 81	7	8 872	5	0.58807440E 06	0.58807440E 06	0.
8	8 80	8	8 817	-6	0.24478352F 07	0.24478352E 07	0.
8	8 80	8	8 935	-2	0.21554500E 07	0.21554500F 07	0.
8	8 80	8	8 853	2	0.15288956F 07	0.15288956E 07	0.
8	8 90	8	8 871	6	0.58807440E 06	0.58807440E 06	0.

42

DIFLUOROETHYLENE RIGID ROTOR TRANSITION FREQUENCES

Input Coefficients

$A = 0.11001000E\ 05$
$R = 0.10427000E\ 05$
$C = 0.53451000E\ 04$

$\mu_a = 1.366$
$K = -0.932077$

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
1	-1	-0	0	0.15772100E 05	0.15772100E 05	0.
1	1	1	0	0.50819000E 04	0.50819000E 04	0.
2	-2	1	-1	0.26990372E 05	0.26990372E 05	0.
2	-1	1	0	0.26462300E 05	0.26462800E 05	0.
2	0	1	1	0.36526100E 05	0.36626100E 05	0.
2	2	1	-1	0.48557827E 05	0.48557827E 05	0.
2	0	2	-1	0.15245700E 05	0.15245700E 05	0.
2	1	2	-2	0.17013627E 05	0.17013627E 05	0.
2	2	2	1	0.45538274E 04	0.45538274E 04	0.
3	-3	2	-2	0.37455482E 05	0.37455482E 05	0.
3	-3	2	2	0.15888027E 05	0.15888027E 05	0.
3	-2	2	-1	0.37411860E 05	0.37411860E 05	0.
3	-1	2	0	0.48810586E 05	0.48813586E 05	0.
3	0	2	1	0.47316300E 05	0.47316300E 05	0.
3	1	2	-2	0.78744572E 05	0.78744572E 05	0.
3	1	2	2	0.57177118E 05	0.57177118E 05	0.
3	2	2	-1	0.92140339E 05	0.92140339E 05	0.
3	3	2	0	0.70741613E 05	0.70741613E 05	0.
3	-1	3	-2	0.26644426E 05	0.26644426E 05	0.
3	0	3	-3	0.26874445E 05	0.26874445E 05	0.
3	1	3	0	0.14414646E 05	0.14414646E 05	0.
3	2	3	-1	0.18094053E 05	0.18094053E 05	0.
3	3	3	-2	0.48575453E 05	0.48575453E 05	0.
3	3	3	2	0.38469736E 04	0.38469736E 04	0.
4	-4	3	-3	0.48123771E 05	0.48123771E 05	0.
4	-4	3	1	0.68346807E 04	0.68346807E 04	0.
4	-3	3	-2	0.48121562E 05	0.48121562E 05	0.
4	-3	3	2	0.33930923E 04	0.33930923E 04	0.
4	-2	3	-1	0.58966161E 05	0.58966161E 05	0.
4	-2	3	3	0.37035134E 05	0.37035134E 05	0.
4	-1	3	0	0.58754529E 05	0.58754529E 05	0.
4	0	3	-3	0.11195202E 06	0.11195202E 06	0.
4	0	3	1	0.70662933E 05	0.70662933E 05	0.
4	1	3	-2	0.11261992E 06	0.11261992E 06	0.
4	1	3	2	0.67891437E 05	0.67891437E 05	0.
4	2	3	-1	0.99305466E 05	0.99305466E 05	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
4	2	3	3	0.77374438E 05	0.77374438E 05	0.
4	3	3	0	0.10480167E 06	0.10480167E 06	0.
4	4	3	-3	0.13473234E 06	0.13473234E 06	0.
4	4	3	1	0.93443249E 05	0.93443249E 05	0.
4	-2	4	-3	0.37489025E 05	0.37489025E 05	0.
4	-1	4	-4	0.37505203E 05	0.37505203E 05	0.
4	0	4	-1	0.26323050E 05	0.26323050E 05	0.
4	1	4	-2	0.27009330E 05	0.27009330E 05	0.
4	2	4	-3	0.77828330E 05	0.77828330E 05	0.
4	2	4	1	0.13329975E 05	0.13329975E 05	0.
4	3	4	-4	0.83552345E 05	0.83552345E 05	0.
4	3	4	0	0.19724092E 05	0.19724092E 05	0.
4	4	4	-1	0.49103365E 05	0.49103365E 05	0.
4	4	4	3	0.30562234E 04	0.30562234E 04	0.
5	-5	4	-4	0.58812592E 05	0.58812592E 05	0.
5	-5	4	0	-0.50156610E 04	-0.50156610E 04	0.
5	-5	4	4	-0.27795977E 05	-0.27795977E 05	0.
5	-4	4	-3	0.58812499E 05	0.58812499E 05	0.
5	-4	4	1	-0.56858551E 04	-0.56858561E 04	0.
5	-3	4	-2	0.69548107E 05	0.69548107E 05	0.
5	-3	4	2	0.29208803E 05	0.29208803E 05	0.
5	-2	4	-1	0.69532888E 05	0.69532888E 05	0.
5	-2	4	3	0.23485746E 05	0.23485746E 05	0.
5	-1	4	-4	0.14444628E 06	0.14444628E 06	0.
5	-1	4	0	0.80618025E 05	0.80618025E 05	0.
5	-1	4	4	0.57837710E 05	0.57837710E 05	0.
5	0	4	-3	0.14451005E 06	0.14451005E 06	0.
5	0	4	1	0.80011696E 05	0.80011696E 05	0.
5	1	4		0.13274054E 06	0.13274054E 06	0.
5	1	4	2	0.92401234E 05	0.92401234E 05	0.
5	2	4	-1	0.13423525E 06	0.13423525E 06	0.
5	2	4	3	0.88188110E 05	0.88188110E 05	0.
5	3	4	-4	0.18375945E 06	0.18375945E 06	0.
5	3	4	0	0.11993120E 06	0.11993120E 06	0.
5	3	4	4	0.97150894E 05	0.97150384E 05	0.
5	4	4	-3	0.19230548E 06	0.19230548E 06	0.
5	4	4	1	0.12780713E 06	0.12780713E 06	0.
5	5	4	-2	0.15710081E 06	0.15710081E 06	0.
5	5	4	2	0.11676150E 06	0.11676150E 06	0.
5	-3	5	-4	0.48224634E 05	0.48224634E 05	0.
5	-2	5	-5	0.48225500E 05	0.48225500E 05	0.
5	-1	5	-2	0.37408187E 05	0.37408187E 05	0.
5	0	5	-3	0.37472918E 05	0.37472918E 05	0.
5	1	5	-4	0.11141707E 06	0.11141707E 06	0.
5	1	5	0	0.25719513E 05	0.25719513E 05	0.
5	2	5	-5	0.11292786E 06	0.11292786E 06	0.
5	2	5	-1	0.27294177E 05	0.27294177E 05	0.
5	3	5	-2	0.76721360E 05	0.76721360E 05	0.
5	3	5	2	0.12018997E 05	0.12018997E 05	0.
5	4	5	-3	0.85268349E 05	0.85268349E 05	0.
5	4	5	1	0.22075918E 05	0.22075918E 05	0.
5	5	5	-4	0.13577733E 06	0.13577733E 06	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
5	5	5	0	0.50079781E 05	0.50079781E 05	0.
5	5	5	4	0.22843499E 04	0.22843499E 04	0.
6	-6	5	-5	0.69502618E 05	0.69502618E 05	0.
6	-6	5	-1	-0.16131068E 05	-0.16131068E 05	0.
6	-6	5	3	-0.55444242E 05	-0.55444242E 05	0.
6	-5	5	-4	0.69502615E 05	0.69502615E 05	0.
6	-5	5	0	-0.16194937E 05	-0.16194937E 05	0.
6	-5	5	4	-0.63990368E 05	-0.63990368E 05	0.
6	-4	5	-3	0.80228179E 05	0.80228179E 05	0.
6	-4	5	1	0.17035748E 05	0.17035748E 05	0.
6	-4	5	5	-0.73245200E 04	-0.73245200E 04	0.
6	-3	5	-2	0.80227357E 05	0.80227357E 05	0.
6	-3	5	2	0.15524993E 05	0.15524993E 05	0.
6	-2	5	-5	0.17663413E 06	0.17663413E 06	0.
6	-2	5	-1	0.91000441E 05	0.91000441E 05	0.
6	-2	5	3	0.51687268E 05	0.51687268E 05	0.
6	-1	5	-4	0.17663841E 06	0.17663841E 06	0.
6	-1	5	0	0.90940861E 05	0.90940861E 05	0.
6	-1	5	4	0.43145431E 05	0.43145431E 05	0.
6	0	5	-3	0.16565873E 06	0.16565873E 06	0.
6	0	5	1	0.10246630E 06	0.10246630E 06	0.
6	0	5	5	0.78106030E 05	0.78106030E 05	0.
6	1	5	-2	0.16584708E 06	0.16584708E 06	0.
6	1	5	2	0.10114472E 06	0.10114472E 06	0.
6	2	5	-5	0.23883452E 06	0.23883452E 06	0.
6	2	5	-1	0.15320083E 06	0.15320083E 06	0.
6	2	5	3	0.11388766E 06	0.11388766E 06	0.
6	3	5	-4	0.24170161E 06	0.24170161E 06	0.
6	3	5	0	0.15600405E 06	0.15600405E 06	0.
6	3	5	4	0.10820862E 06	0.10820862E 06	0.
6	4	5	-3	0.20400172E 06	0.20400172E 06	0.
6	4	5	1	0.14080929E 06	0.14080929E 06	0.
6	4	5	5	0.11644902E 06	0.11644902E 06	0.
6	5	5	-2	0.21586560E 06	0.21586560E 06	0.
6	5	5	2	0.15116324E 06	0.15116324E 06	0.
6	6	5	-5	0.26570506E 06	0.26570506E 06	0.
6	6	5	-1	0.18007138E 06	0.18007138E 06	0.
6	6	5	3	0.14075820E 06	0.14075820E 06	0.
6	-4	6	-5	0.58950198E 05	0.58950198E 05	0.
6	-3	6	-6	0.58950238E 05	0.58950238E 05	0.
6	-2	6	-3	0.48181271E 05	0.48181271E 05	0.
6	-1	6	-4	0.48185601E 05	0.48185601E 05	0.
6	0	6	-5	0.14438075E 06	0.14438075E 06	0.
6	0	6	-1	0.37244950E 05	0.37244950E 05	0.
6	1	6	-6	0.14456996E 06	0.14456996E 06	0.
6	1	6	-2	0.37438457E 05	0.37438457E 05	0.
6	2	6	-3	0.11038166E 06	0.11038166E 06	0.
6	2	6	1	0.24761932E 05	0.24761932E 05	0.
6	3	6	-4	0.11324879E 06	0.11324879E 06	0.
6	3	6	0	0.27818242E 05	0.27818242E 05	0.
6	4	6	-5	0.18272374E 06	0.18272374E 06	0.
6	4	6	-1	0.75587942E 05	0.75587942E 05	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
6	4	6	3	0.10524751E 05	0.10524751E 05	0.
6	5	6	-6	0.19458848E 06	0.19458848E 06	0.
6	5	6	-2	0.87456976E 05	0.87456976E 05	0.
6	5	6	2	0.25256587E 05	0.25256587E 05	0.
6	6	6	-3	0.13725221E 06	0.13725221E 06	0.
6	6	6	1	0.51632479E 05	0.51632479E 05	0.
6	6	6	5	0.16139608E 04	0.16139608E 04	0.
7	-7	6	-6	0.80192750E 05	0.80192750E 05	0.
7	-7	6	-2	-0.26938759E 05	-0.26938759E 05	0.
7	-7	6	2	-0.89139147E 05	-0.89139147E 05	0.
7	-7	6	6	-0.11600970E 05	-0.11600970E 05	0.
7	-6	6	-5	0.80192750E 05	0.80192750E 05	0.
7	-6	6	-1	-0.26943049E 05	-0.26943049E 05	0.
7	-6	6	3	-0.92006240E 05	-0.92006240E 05	0.
7	-5	6	-4	0.90916824E 05	0.90916824E 05	0.
7	-5	6	0	0.54862737E 04	0.54862737E 04	0.
7	-5	6	4	-0.32856719E 05	-0.32856719E 05	0.
7	-4	6	-3	0.90916786E 05	0.90916786E 05	0.
7	-4	6	1	0.52970583E 04	0.52970583E 04	0.
7	-4	6	5	-0.44721460E 05	-0.44721460E 05	0.
7	-3	6	-6	0.20878256E 06	0.20878256E 06	0.
7	-3	6	-2	0.10165105E 06	0.10165105E 06	0.
7	-3	6	2	0.39450665E 05	0.39450665E 05	0.
7	-3	6	6	0.12580117E 05	0.12580117E 05	0.
7	-2	6	-5	0.20878280E 06	0.20878280E 06	0.
7	-2	6	-1	0.10164700E 06	0.10164700E 06	0.
7	-2	6	3	0.36583808E 05	0.36583808E 05	0.
7	-1	6	-4	0.19794164E 06	0.19794164E 06	0.
7	-1	6	0	0.11251109E 06	0.11251109E 06	0.
7	-1	6	4	0.74168094E 05	0.74168094E 05	0.
7	0	6	-3	0.19795722E 06	0.19795722E 06	0.
7	0	6	1	0.11233750E 06	0.11233750E 06	0.
7	0	6	5	0.62318976E 05	0.62318976E 05	0.
7	1	6	-6	0.29385066E 06	0.29385066E 06	0.
7	1	6	-2	0.18671915E 06	0.18671915E 06	0.
7	1	6	2	0.12451876E 06	0.12451876E 06	0.
7	1	6	6	0.97648210E 05	0.97648210E 05	0.
7	2	6	-5	0.29431409E 06	0.29431409E 06	0.
7	2	6	-1	0.18717829E 06	0.18717829E 06	0.
7	2	6	3	0.12211509E 06	0.12211509E 06	0.
7	3	6	-4	0.25878699E 06	0.25878699E 06	0.
7	3	6	0	0.17335644E 06	0.17335644E 06	0.
7	3	6	4	0.13501345E 06	0.13501345E 06	0.
7	4	6	-3	0.26359806E 06	0.26359806E 06	0.
7	4	6	1	0.17797834E 06	0.17797834E 06	0.
7	4	6	5	0.12795982E 06	0.12795982E 06	0.
7	5	6	-6	0.33145868E 06	0.33145868E 06	0.
7	5	6	-2	0.22432717E 06	0.22432717E 06	0.
7	5	6	2	0.16212678E 06	0.16212678E 06	0.
7	5	6	6	0.13525623E 06	0.13525623E 06	0.
7	6	6	-5	0.34706701E 06	0.34706701E 06	0.
7	6	6	-1	0.23993121E 06	0.23993121E 06	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
7	6	6	3	0.17486802E 06	0.17486802E 06	0.
7	7	6	-4	0.28920360E 06	0.28920360E 06	0.
7	7	6	0	0.20377305E 06	0.20377305E 06	0.
7	7	6	4	0.16543006E 06	0.16543006E 06	0.
7	-5	7	-6	0.69674271E 05	0.69674271E 05	0.
7	-4	7	-7	0.69674273E 05	0.69674273E 05	0.
7	-3	7	-4	0.58915538E 05	0.58915538E 05	0.
7	-2	7	-5	0.58915777E 05	0.58915777E 05	0.
7	-1	7	-6	0.17669908E 06	0.17669908E 06	0.
7	-1	7	-2	0.48109036E 05	0.48109036E 05	0.
7	0	7	-7	0.17671471E 06	0.17671471E 06	0.
7	0	7	-3	0.48124898E 05	0.48124898E 05	0.
7	1	7	-4	0.14398363E 06	0.14398363E 06	0.
7	1	7	0	0.36943195E 05	0.36943195E 05	0.
7	2	7	-5	0.14444706E 06	0.14444706E 06	0.
7	2	7	-1	0.37422250E 05	0.37422250E 05	0.
7	3	7	-6	0.23754444E 06	0.23754444E 06	0.
7	3	7	-2	0.10895439E 06	0.10895439E 06	0.
7	3	7	2	0.23423102E 05	0.23423102E 05	0.
7	4	7	-7	0.24235555E 06	0.24235555E 06	0.
7	4	7	-3	0.11376574E 06	0.11376574E 06	0.
7	4	7	1	0.28697646E 05	0.28697646E 05	0.
7	5	7	-4	0.18159166E 06	0.18159166E 06	0.
7	5	7	0	0.74551220E 05	0.74551220E 05	0.
7	5	7	4	0.89103785E 04	0.89103785E 04	0.
7	6	7	-5	0.19719999E 06	0.19719999E 06	0.
7	6	7	-1	0.90175178E 05	0.90175178E 05	0.
7	6	7	3	0.29329826E 05	0.29329826E 05	0.
7	7	7	-6	0.26796105E 06	0.26796105E 06	0.
7	7	7	-2	0.13937100E 06	0.13937100E 06	0.
7	7	7	2	0.53839717E 05	0.53839717E 05	0.
7	7	7	6	0.10867893E 04	0.10867893E 04	0.
8	-8	7	-7	0.90882912E 05	0.90882912E 05	0.
9	-8	7	-3	-0.37706899E 05	-0.37706899E 05	0.
8	-8	7	1	-0.12277499E 06	-0.12277499E 06	0.
9	-8	7	5	-0.16038302E 06	-0.16038302E 06	0.
8	-7	7	-6	0.90882912E 05	0.90882912E 05	0.
8	-7	7	-2	-0.37707136E 05	-0.37707136E 05	0.
8	-7	7	2	-0.12323842E 06	-0.12323842E 06	0.
8	-7	7	6	-0.17599135E 06	-0.17599135E 06	0.
8	-6	7	-5	0.10160642E 06	0.10160642E 06	0.
8	-6	7	-1	-0.54183871E 04	-0.54183871E 04	0.
8	-6	7	3	-0.66263739E 05	-0.66263739E 05	0.
8	-6	7	7	-0.96680354E 05	-0.96680354E 05	0.
8	-5	7	-4	0.10160642E 06	0.10160642E 06	0.
8	-5	7	0	-0.54340129E 04	-0.54340129E 04	0.
8	-5	7	4	-0.71074854E 05	-0.71074854E 05	0.
9	-4	7	-7	0.24092450E 06	0.24092450E 06	0.
8	-4	7	-3	0.11233469E 06	0.11233469E 06	0.
8	-4	7	1	0.27266599E 05	0.27266599E 05	0.
8	-4	7	5	-0.10341426E 05	-0.10341426E 05	0.
8	-3	7	-6	0.24092452E 06	0.24092462E 06	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
8	-3	7	-2	0.11233447E 06	0.11233447E 06	0.
8	-3	7	2	0.26803180E 05	0.26803180E 05	0.
8	-3	7	6	-0.25949747E 05	-0.25949747E 05	0.
8	-2	7	-5	0.23011365E 06	0.23011365E 06	0.
8	-2	7	-1	0.12308884E 06	0.12308884E 06	0.
8	-2	7	3	0.62243487E 05	0.62243487E 05	0.
8	-2	7	7	0.31826872E 05	0.31826872E 05	0.
8	-1	7	-4	0.23011467E 06	0.23011467E 06	0.
8	-1	7	0	0.12307424E 06	0.12307424E 06	0.
8	-1	7	4	0.57433396E 05	0.57433396E 05	0.
8	0	7	-7	0.34778208E 06	0.34778208E 06	0.
8	0	7	-3	0.21919227E 06	0.21919227E 06	0.
8	0	7	1	0.13412418E 06	0.13412418E 06	0.
8	0	7	5	0.96516152E 05	0.96516152E 05	0.
8	1	7	-6	0.34782849E 06	0.34782849E 06	0.
8	1	7	-2	0.21923844E 06	0.21923844E 06	0.
8	1	7	2	0.13370716E 06	0.13370716E 06	0.
8	1	7	6	0.80954229E 05	0.80954229E 05	0.
8	2	7	-5	0.31458119E 06	0.31458119E 06	0.
8	2	7	-1	0.20755638E 06	0.20755638E 06	0.
8	2	7	3	0.14671103E 06	0.14671103E 06	0.
8	2	7	7	0.11629441E 06	0.11629441E 06	0.
8	3	7	-4	0.31556895E 06	0.31556895E 06	0.
8	3	7	0	0.20852851E 06	0.20852851E 06	0.
8	3	7	4	0.14288767E 06	0.14288767E 06	0.
8	4	7	-7	0.40696521E 06	0.40696521E 06	0.
8	4	7	-3	0.27837540E 06	0.27837540E 06	0.
8	4	7	1	0.19330731E 06	0.19330731E 06	0.
8	4	7	5	0.15569929E 06	0.15569929E 06	0.
8	5	7	-6	0.41432932E 06	0.41432932E 06	0.
8	5	7	-2	0.28573927E 06	0.28573927E 06	0.
8	5	7	2	0.20020799E 06	0.20020799E 06	0.
8	5	7	6	0.14745506E 06	0.14745506E 06	0.
8	6	7	-5	0.35191529E 06	0.35191529E 06	0.
8	6	7	-1	0.24489047E 06	0.24489047E 06	0.
8	6	7	3	0.18404512E 06	0.18404512E 06	0.
8	6	7	7	0.15362850E 06	0.15362850E 06	0.
8	7	7	-4	0.37159050E 06	0.37159050E 06	0.
8	7	7	0	0.26455007E 06	0.26455007E 06	0.
8	7	7	4	0.19890922E 06	0.19890922E 06	0.
8	8	7	-7	0.44196484E 06	0.44196484E 06	0.
8	8	7	-3	0.31337902E 06	0.31337902E 06	0.
8	8	7	1	0.22831093E 06	0.22831093E 06	0.
8	8	7	5	0.19070291E 06	0.19070291E 06	0.
8	-6	8	-7	0.80397795E 05	0.80397785E 05	0.
8	-5	8	-8	0.80397785E 05	0.80397785E 05	0.
8	-4	8	-5	0.69643807E 05	0.69643807E 05	0.
8	-3	8	-6	0.69643818E 05	0.69643818E 05	0.
8	-2	8	-7	0.20890501E 06	0.20890501E 06	0.
8	-2	8	-3	0.58863409E 05	0.58863409E 05	0.
8	-1	8	-8	0.20890604E 06	0.20890604E 06	0.
8	-1	8	-4	0.58864443E 05	0.58864443E 05	0.

48

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
8	0	8	-5	0.17650138E 06	0.17650138E 06	0.
8	0	8	-1	0.47993135E 05	0.47993135E 05	0.
9	1	8	-6	0.17654779E 06	0.17654779E 06	0.
8	1	8	-2	0.48040568E 05	0.48040569E 05	0.
8	2	9	-7	0.29337255E 06	0.29337255E 06	0.
8	2	8	-3	0.14333095E 06	0.14333095E 06	0.
8	2	9	1	0.36426972E 05	0.36426972E 05	0.
8	3	8	-8	0.29436031E 06	0.29436031E 06	0.
8	3	8	-4	0.14431872E 06	0.14431872E 06	0.
9	3	8	0	0.37461140E 05	0.37461140E 05	0.
9	4	8	-5	0.23568452E 06	0.23568452E 06	0.
8	4	8	-1	0.10717627E 06	0.10717627E 06	0.
8	4	8	3	0.21721995E 05	0.21721995E 05	0.
8	5	8	-5	0.24304862E 05	0.24304862E 06	0.
9	5	8	-2	0.11454140E 06	0.11454140E 06	0.
9	5	8	2	0.30073858E 05	0.30073858E 05	0.
8	6	8	-7	0.33070664E 06	0.33070664E 06	0.
9	6	8	-3	0.18066504E 06	0.18066504E 06	0.
9	6	8	1	0.73761063E 05	0.73761063E 05	0.
8	6	8	5	0.72602339E 04	0.72602339E 04	0.
8	7	8	-8	0.35038186E 06	0.35038186E 06	0.
8	7	8	-4	0.20034027E 06	0.20034027E 06	0.
9	7	8	0	0.93482694E 05	0.93482694E 05	0.
8	7	8	4	0.34299559E 05	0.34299559E 05	0.
9	8	8	-5	0.27068814E 06	0.27068814E 06	0.
8	8	8	-1	0.14217989E 06	0.14217989E 06	0.
8	8	8	3	0.56725615E 05	0.56725615E 05	0.
8	8	8	7	0.70406136E 03	0.70406136E 03	0.

VINYL CYANIDE RIGID ROTOR TRANSITION FREQUENCIES

Input Coefficients

A = 0.49076200E 05
B = 0.49713300E 04
C = 0.45140500E 04

μ = 3.89
μ_a = 3.68
μ_b = 1.25

K = -0.979477

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
1	-1	-0	0	0.94853800E 04	0.94853800E 04	0.
1	0	-0	0	0.53590250E 05	0.53590250E 05	0.
1	1	1	-1	0.44562150E 05	0.44562150E 05	0.
1	1	1	0	0.45728002E 03	0.45728002E 03	0.
2	-2	1	-1	0.18967223E 05	0.18967223E 05	0.
2	-2	1	0	-0.25137647E 05	-0.25137647E 05	0.
2	-1	1	-1	0.62618350E 05	0.62618350E 05	0.
2	-1	1	0	0.18513480E 05	0.18513480E 05	0.
2	0	1	1	0.19428040E 05	0.19428040E 05	0.
2	1	1	1	0.15174265E 06	0.15174265E 06	0.
2	2	1	-1	0.19630834E 06	0.19630834E 06	0.
2	2	1	0	0.15220347E 06	0.15220347E 06	0.
2	0	2	-2	0.45022967E 05	0.45022967E 05	0.
2	0	2	-1	0.13718401E 04	0.13718401E 04	0.
2	1	2	-2	0.17733758E 06	0.17733758E 06	0.
2	1	2	-1	0.13368645E 06	0.13368645E 06	0.
2	2	2	0	0.13231815E 06	0.13231815E 06	0.
2	2	2	1	0.35374063E 01	0.35374063E 01	0.
3	-3	2	-2	0.28441992E 05	0.28441992E 05	0.
3	-3	2	-1	-0.15209135E 05	-0.15209135E 05	0.
3	-3	2	2	-0.14889912E 06	-0.14889912E 06	0.
3	-2	2	-2	0.71419146E 05	0.71419146E 05	0.
3	-2	2	-1	0.27768020E 05	0.27768020E 05	0.
4	-2	2	2	-0.10592197E 06	-0.10592197E 06	0.
3	-1	2	0	0.29139843E 05	0.29139843E 05	0.
3	-1	2	1	-0.10317477E 06	-0.10317477E 06	0.
3	0	2	0	0.16077075E 06	0.16077075E 06	0.
3	0	2	1	0.28456140E 05	0.28456140E 05	0.
3	1	2	-2	0.20581140E 06	0.20581140E 06	0.
3	1	2	-1	0.16216029E 06	0.16216028E 06	0.
3	1	2	2	0.28470288E 05	0.28470288E 05	0.
3	2	2	-2	0.42746346E 06	0.42746346E 06	0.
3	2	2	-1	0.38381234E 06	0.38381234E 06	0.
3	2	2	2	0.25012235E 06	0.25012235E 06	0.
3	3	2	0	0.38244052E 06	0.38244052E 06	0.
3	3	2	1	0.25012591E 06	0.25012591E 06	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
3	-1	3	-3	0.45720818E 05	0.45720818E 05	0.
3	-1	3	-2	0.27436630E 04	0.27436630F 04	0.
3	0	3	-3	0.17735172E 06	0.17735172E 06	0.
3	0	3	-2	0.13437457E 06	0.13437457E 06	0.
3	1	3	-1	0.13164859E 06	0.13164859E 06	0.
3	1	3	0	0.17685620E 02	0.17685620E 02	0.
3	2	3	-1	0.35330066E 06	0.35330066E 06	0.
3	2	3	0	0.22166975E 06	0.22166975E 06	0.
3	3	3	-3	0.39902149E 06	0.39902149E 06	0.
3	3	3	-2	0.35604434E 06	0.35604434E 06	0.
3	3	3	1	0.22165208E 06	0.22165208E 06	0.
3	3	3	2	0.17103452E-01	0.17103452E-01	0.
4	-4	3	-3	0.37906161E 05	0.37906161F 05	0.
4	-4	3	-2	-0.50709937E 04	-0.50709937E 04	0.
4	-4	3	1	-0.13946325E 06	-0.13946325E 06	0.
4	-4	3	2	-0.36111531E 06	-0.36111531E 06	0.
4	-3	3	-3	0.79997094E 05	0.79997094F 05	0.
4	-3	3	-2	0.37019939E 05	0.37019939E 05	0.
4	-3	3	1	-0.97372317E 05	-0.97372317E 05	0.
4	-3	3	2	-0.31902438E 06	-0.31902438E 06	0.
4	-2	3	-1	0.38848956E 05	0.38848956E 05	0.
4	-2	3	0	-0.92781951E 05	-0.92781951E 05	0.
4	-2	3	3	-0.31445171E 06	-0.31445171E 06	0.
4	-1	3	-1	0.16956968E 06	0.16956968E 06	0.
4	-1	3	0	0.37938771E 05	0.37938771E 05	0.
4	-1	3	3	-0.18373099E 06	-0.18373099E 06	0.
4	0	3	-3	0.21534354E 06	0.21534354E 06	G.
4	0	3	-2	0.17236639E 06	0.17236639E 06	U.
4	0	3	1	0.37974132E 05	0.37974132E 05	0.
4	0	3	2	-0.18367793E 06	-0.18367793E 06	0.
4	1	3	-3	0.43397002E 06	0.43697002E 06	0.
4	1	3	-2	0.39399287E 06	0.39399287E 06	0.
4	1	3	1	0.25960061E 06	0.25960061E 06	0.
4	1	3	2	0.37948546E 05	0.37948546E 05	0.
4	2	3	-1	0.39124932E 06	0.39124932E 06	0.
4	2	3	0	0.25961842E 06	0.25961842E 06	0.
4	2	3	3	0.37948649E 05	0.37948649E 05	0.
4	3	3	-1	0.70157730E 06	0.70157730E 06	0.
4	3	3	0	0.56994639E 06	0.56994639E 06	0.
4	3	3	3	0.34827663E 06	0.34827663E 06	0.
4	4	3	-3	0.74729812E 06	0.74729812E 06	0.
4	4	3	-2	0.70432096E 06	0.70432096F 06	0.
4	4	3	1	0.56992870E 06	0.56992870E 06	
4	4	3	2	0.34827664E 06	0.34827664E 06	0.
4	-2	4	-4	0.46663613E 05	0.46663613E 05	0.
4	-2	4	-3	0.45726805E 04	0.45726805E 04	0.
4	-1	4	-4	0.17738434E 06	0.17738434E 08	0.
4	-1	4	-3	0.13529340E 06	0.13529340E 06	0.
4	0	4	-2	0.13077377E 06	0.13077377E 06	0.
4	0	4	-1	0.53046833E 02	0.53046833E 02	0.
4	1	4	-2	0.35240025E 06	0.35240025E 06	0.
4	1	4	-1	0.22167952E 06	0.22167952E 06	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
4	2	4	-4	0.39906398E 06	0.39906398E 06	0.
4	2	4	-3	0.35697305E 06	0.35697305E 06	0.
4	2	4	0	0.22162460E 06	0.22162660E 06	0.
4	2	4	1	0.11972008E-00	0.11972008E-00	0.
4	3	4	-4	0.70939196E 06	0.70939196E 06	0.
4	3	4	-3	0.66730102E 06	0.66730102E 06	0.
4	3	4	0	0.53195457E 06	0.53195457E 06	0.
4	3	4	1	0.31032810E 06	0.31032810E 06	0.
4	4	4	-2	0.66272834E 06	0.66272934E 06	0.
4	4	4	-1	0.53200762E 06	0.53200762E 06	0.
4	4	4	2	0.31032798E 06	0.31032798E 06	0.
4	4	4	3	0.68606227E-04	0.68606227E-04	0.
5	-5	4	-4	0.47356217E 05	0.47356217E 05	0.
5	-5	4	-3	0.52652848E 04	0.52652848E 04	0.
5	-5	4	0	-0.13008117E 06	-0.13008117E 06	0.
5	-5	4	1	-0.35170764E 06	-0.35170764E 06	0.
5	-5	4	4	-0.66203574E 06	-0.66203574E 06	0.
5	-4	4	-4	0.88359336E 05	0.88359336E 05	0.
5	-4	4	-3	0.46268404E 05	0.46268404E 05	0.
5	-4	4	0	-0.89078046E 05	-0.89078045E 05	0.
5	-4	4	1	-0.31070452E 06	-0.31070452E 06	0.
5	-4	4	4	-0.62103262E 06	-0.62103262E 06	0.
5	-3	4	-2	0.48554445E 05	0.48554445E 05	0.
5	-3	4	-1	-0.82166277E 05	-0.82166277E 05	0.
5	-3	4	2	-0.30384592E 06	-0.30384592E 06	0.
5	-3	4	3	-0.61417390E 06	-0.61417390E 06	0.
5	-2	4	-2	0.17813977E 06	0.17813977E 06	0.
5	-2	4	-1	0.47419043E 05	0.47419043E 05	0.
5	-2	4	2	-0.17426060E 06	-0.17426060E 06	0.
5	-2	4	3	-0.48458858E 06	-0.48458858E 06	0.
5	-1	4	-4	0.22492711E 06	0.22492711E 06	0.
5	-1	4	-3	0.18283618E 06	0.18283618E 06	0.
5	-1	4	0	0.47489727E 05	0.47489727E 05	0.
5	-1	4	1	-0.17413675E 06	-0.17413675E 06	0.
5	-1	4	4	-0.48466485E 06	-0.48466485E 06	0.
5	0	4	-4	0.44650274E 06	0.44650274E 06	0.
5	0	4	-3	0.40441191E 06	0.40441191E 06	0.
5	0	4	0	0.26906536E 06	0.26906536E 06	0.
5	0	4	1	0.47438992E 05	0.47438992E 05	0.
5	0	4	4	-0.26288921E 06	-0.26288921E 06	0.
5	1	4	-2	0.39983961E 06	0.39983961E 06	0.
5	1	4	-1	0.26911888E 06	0.26911888E 06	0.
5	1	4	2	0.47439242E 05	0.47439242E 05	0.
5	1	4	3	-0.26288873E 06	-0.26288873E 06	0.
5	2	4	-2	0.71016311E 06	0.71016311E 06	0.
5	2	4	-1	0.57944238E 06	0.57944238E 06	0.
5	2	4	2	0.35776274E 06	0.35776274E 06	0.
5	2	4	3	0.47434762E 05	0.47434762E 05	0.
5	3	4	-4	0.75682672E 06	0.75682672E 06	0.
5	3	4	-3	0.71473579E 06	0.71473579E 06	0.
5	3	4	0	0.57938934E 06	0.57938934E 06	0.
5	3	4	1	0.35776286E 06	0.35776286E 06	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
5	3	4	4	0.47434763E 05	0.47434763E 05	0.
5	4	4	-4	0.11558210E 07	0.11558210E 07	0.
5	4	4	-3	0.11137301E 07	0.11137301E 07	0.
5	4	4	0	0.97838362E 06	0.97838362E 06	0.
5	4	4	1	0.75675715E 06	0.75675715E 06	0.
5	4	4	4	0.44642905E 06	0.44642905E 06	0.
5	5	4	-2	0.11091574E 07	0.11091574E 07	0.
5	5	4	-1	0.97843667E 06	0.97843667E 06	0.
5	5	4	2	0.75675703E 06	0.75675703E 06	0.
5	5	4	3	0.44642905E 06	0.44642905E 06	0.
5	-3	5	-5	0.47861840E 05	0.47861840E 05	0.
5	-3	5	-4	0.68587215E 04	0.68587215E 04	0.
5	-2	5	-5	0.17744716E 06	0.17744716E 06	0.
5	-2	5	-4	0.13644404E 06	0.13644404E 06	0.
5	-1	5	-3	0.12970905E 06	0.12970905E 06	0.
5	-1	5	-2	0.12373029E 03	0.12373029E 03	0.
5	0	5	-3	0.35128468E 06	0.35128469E 06	0.
5	0	5	-2	0.22169936E 06	0.22169936E 06	0.
5	1	5	-5	0.39914700E 06	0.39914700E 06	0.
5	1	5	-4	0.35814398E 06	0.35814388E 06	0.
5	1	5	-1	0.22157611E 06	0.22157611E 06	0.
5	1	5	0	0.47884920E-30	0.47884920E-00	0.
5	2	5	-5	0.70947050E 06	0.70947050E 06	0.
5	2	5	-4	0.66846738E 06	0.66846738E 06	0.
5	2	5	-1	0.53189961E 06	0.53189961E 06	0.
5	2	5	0	0.31032398E 06	0.31032398E 06	0.
5	3	5	-3	0.66160966E 06	0.66160866E 06	0.
5	3	5	-2	0.53202334E 06	0.53202334E 06	0.
5	3	5	1	0.31032350E 06	0.31032350E 06	0.
5	3	5	2	0.61744156E-03	0.61744166E-03	0.
5	4	5	-3	0.10606030E 07	0.10606030E 07	0.
5	4	5	-2	0.93101763E 06	0.93101763E 06	0.
5	4	5	1	0.70931779E 06	0.70931779E 06	0.
5	4	5	2	0.39899429E 06	0.39899429E 06	0.
5	5	5	-5	0.11084648E 07	0.11084648E 07	0.
5	5	5	-4	0.10674617E 07	0.10674617E 07	0.
5	5	5	-1	0.93089390E 06	0.93089390E 06	0.
5	5	5	0	0.70931827E 06	0.70931827E 06	0.
5	5	5	3	0.39899429E 06	0.39899429E 06	0.
5	5	5	4	0.24877954E-06	0.24877954E-06	0.
6	-6	5	-5	0.56788702E 05	0.56788702E 05	0.
6	-6	5	-4	0.15785583E 05	0.15795583E 05	0.
6	-6	5	-1	-0.12078219E 06	-0.12078219E 06	0.
6	-6	5	0	-0.34235792E 06	-0.34235782E 06	0.
6	-6	5	3	-0.65268180E 06	-0.65268180E 06	0.
6	-6	5	4	-0.10516761E 07	-0.10516761E 07	0.
6	-5	5	-5	0.96515733E 05	0.96515733E 05	0.
6	-5	5	-4	0.55512614E 05	0.55512614E 05	0.
6	-5	5	-1	-0.81055158E 05	-0.81055158E 05	0.
6	-5	5	0	-0.30263079E 06	-0.30263079E 06	0.
6	-5	5	3	-0.61295477E 06	-0.61295477E 06	0.
6	-5	5	4	-0.10119491E 07	-0.10119491E 07	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
6	-4	5	-3	0.58255336E 05	0.58255336E 05	0.
6	-4	5	-2	-0.71329963E 05	-0.71329963E 05	0.
6	-4	5	1	-0.29302982E 06	-0.29302982E 06	0.
6	-4	5	2	-0.60335333E 06	-0.60335333E 06	0.
6	-4	5	5	-0.10023476E 07	-0.10023476E 07	0.
6	-3	5	-3	0.18648159E 06	0.18648169E 06	0.
6	-3	5	-2	0.56896365E 05	0.56896365E 05	0.
6	-3	5	1	-0.16480348E 06	-0.16480348E 06	0.
6	-3	5	2	-0.47512698E 06	-0.47512698E 06	0.
6	-3	5	5	-0.87412127E 06	-0.87412127E 06	0.
6	-2	5	-5	0.23459083E 06	0.23459083E 06	0.
6	-2	5	-4	0.19358771E 06	0.19358771E 06	0.
6	-2	5	-1	0.57019938E 05	0.57019938E 05	0.
6	-2	5	0	-0.16455570E 06	-0.16455570E 06	0.
6	-2	5	3	-0.47487368E 06	-0.47487368E 06	0.
6	-2	5	4	-0.87387396E 06	-0.87387396E 06	0.
6	-1	5	-5	0.45607778E 06	0.45607778E 06	0.
6	-1	5	-4	0.41507466E 06	0.41507466E 06	0.
6	-1	5	-1	0.27850689E 06	0.27850689E 06	0.
6	-1	5	0	0.56931257E 05	0.56931257E 05	0.
6	-1	5	3	-0.25339272E 06	-0.25339272E 06	0.
6	-1	5	4	-0.65238701E 06	-0.65238701E 06	0.
6	0	5	-3	0.40821738E 06	0.40821738E 06	0.
6	0	5	-2	0.27863205E 06	0.27863205E 06	0.
6	0	5	1	0.56932214E 05	0.56932214E 05	0.
6	0	5	2	-0.25339129E 06	-0.25339129E 06	0.
6	0	5	5	-0.65238558E 06	-0.65238558E 06	0.
6	1	5	-3	0.71853297E 06	0.71853297E 06	0.
6	1	5	-2	0.58894764E 06	0.58894764E 06	0.
6	1	5	1	0.36724780E 06	0.36724780E 06	0.
6	1	5	2	0.56924304E 05	0.56924304E 05	0.
6	1	5	5	-0.34206999E 06	-0.34206999E 06	0.
6	2	5	-5	0.76639481E 06	0.76639481E 06	0.
6	2	5	-4	0.72539169E 06	0.72539167E 06	0.
6	2	5	-1	0.58982391E 06	0.58982391E 06	0.
6	2	5	0	0.36724829E 06	0.36724829E 06	0.
6	2	5	3	0.56924306E 05	0.56924306E 05	0.
6	2	5	4	-0.34206998E 06	-0.34206998E 06	0.
6	3	5	-5	0.11653859E 07	0.11653859E 07	0.
6	3	5	-4	0.11243828E 07	0.11243828E 07	0.
6	3	5	-1	0.98781502E 06	0.98781502E 06	0.
6	3	5	0	0.76623939E 06	0.76623939E 06	0.
6	3	5	3	0.45591541E 06	0.45591541E 06	0.
6	3	5	4	0.56921121E 05	0.36921121E 05	0.
6	4	5	-3	0.11175241E 07	0.11175241E 07	0.
6	4	5	-2	0.98793875E 06	0.98793875E 06	0.
6	4	5	1	0.76623491E 06	0.76623491E 06	0.
6	4	5	2	0.45591541E 06	0.45591541E 06	0.
6	4	5	5	0.56921121E 05	0.56921121E 05	0.
6	5	5	-3	0.16051844E 07	0.16051844E 07	0.
6	5	5	-2	0.14755991E 07	0.14755991E 07	0.
6	5	5	1	0.12539992E 07	0.12539992E 07	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
6	5	5	2	0.94357574E 06	0.94357574E 06	0.
6	5	5	5	0.54458145E 06	0.54458145E 06	0.
6	5	5	-5	0.16530462E 07	0.16530462E 07	0.
6	5	5	-4	0.16120431E 07	0.16120431E 07	0.
6	5	5	-1	0.14754754E 07	0.14754754E 07	0.
6	6	5	0	0.12538997E 07	0.12538997E 07	0.
6	6	5	3	0.94357574E 06	0.94357574E 06	0.
6	6	5	4	0.54458145E 06	0.54458145E 06	0.
6	-4	6	-6	0.49328475E 05	0.49328475E 05	0.
6	-4	6	-5	0.96014441E 04	0.96014441E 04	0.
6	-3	6	-6	0.17755482E 06	0.17755482E 06	0.
6	-3	6	-5	0.13782779E 06	0.13782779E 06	0.
6	-2	5	-4	0.12847365E 06	0.12847365E 06	0.
6	-2	6	-3	0.24730313E 03	0.24730313E 03	0.
6	-1	6	-4	0.34996061E 06	0.34996061E 06	0.
6	-1	6	-3	0.22173426E 06	0.22173426E 06	0.
6	0	6	-6	0.39929052E 06	0.39929052E 06	0.
6	0	6	-5	0.35956348E 06	0.35956348E 06	0.
6	0	6	-2	0.22148839E 06	0.22148839E 06	0.
6	0	6	-1	0.14363863E 01	0.14363863E 01	0.
6	1	6	-6	0.70960610E 06	0.70960610E 06	0.
6	1	6	-5	0.66987907E 06	0.66987907E 06	0.
6	1	6	-2	0.53180398E 06	0.53190399E 06	0.
6	1	6	-1	0.31031702E 06	0.31031702E 06	0.
6	2	6	-4	0.66027763E 06	0.66027763E 06	0.
6	2	6	-3	0.53205128E 06	0.53205128E 06	0.
6	2	6	0	0.31031559E 06	0.31031559E 06	0.
6	2	6	1	0.30870902E-02	0.30870902E-02	0.
6	3	6	-4	0.10592687E 07	0.10592687E 07	0.
6	3	6	-3	0.93104239E 06	0.93104239E 06	0.
6	3	6	0	0.70930670E 06	0.70930670E 06	0.
6	3	6	1	0.39899111E 06	0.39899111E 06	0.
6	4	6	-6	0.11045972E 07	0.11045972E 07	0.
6	4	6	-5	0.10688702E 07	0.10688702E 07	0.
6	4	6	-2	0.93079509E 06	0.93079509E 06	0.
6	4	6	-1	0.70930813E 06	0.70930813E 06	0.
6	4	6	2	0.39899111E 06	0.39899111E 06	0.
6	4	6	3	0.27365750E-05	0.27365750E-05	0.
6	5	6	-6	0.15962575E 07	0.15962575E 07	0.
6	5	6	-5	0.15565305E 07	0.15565305E 07	0.
6	5	6	-2	0.14184554E 07	0.14184554E 07	0.
6	5	6	-1	0.11969685E 07	0.11969685E 07	0.
6	5	6	2	0.98665144E 06	0.88665144E 06	0.
6	6	6	3	0.48766033E 06	0.48766033E 06	0.
6	6	6	-4	0.15469291E 07	0.15469291E 07	0.
6	6	6	-3	0.14187027E 07	0.14187027E 07	0.
6	6	6	0	0.11969670E 07	0.11969670E 07	0.
6	6	6	1	0.98665144E 06	0.88665144E 06	0.
6	6	6	4	0.48766033E 06	0.48766033E 06	0.
6	6	6	5	0.81490725E-09	0.81490725E-09	0.

FORMALDEHYDE RIGID ROTOR TRANSITION FREQUENCIES

Input Coefficients

A = 0.29210600E 06 μ_a = 2.31
B = 0.38834000E 05
C = 0.34004000E 05   K = 0.96106

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
1	-1	-0	0	0.72838000E 05	0.72838000E 05	0.
1	1	1	0	0.48299999E 04	0.48299999E 04	0.
2	-2	1	-1	0.14560479E 06	0.14560479E 06	0.
2	-1	1	0	0.14084600E 06	0.14084600E 06	0.
2	0	1	1	0.15050600E 06	0.15050600E 06	0.
2	2	1	-1	0.11284952E 07	0.11284952E 07	0.
2	0	2	-1	0.14490000E 05	0.14490000E 05	0.
2	1	2	-2	0.98281920E 06	0.98281920E 06	0.
2	2	2	1	0.71210145E 02	0.71210145E 02	0.
3	-3	2	-2	0.21822926E 06	0.21822926E 06	0.
3	-3	2	2	-0.76466115E 06	-0.76466115E 06	0.
3	-2	2	-1	0.21122483E 06	0.21122483E 06	0.
3	-1	2	0	0.22571417E 06	0.22571417E 06	0.
3	0	2	1	0.21851400E 06	0.21851400E 06	0.
3	1	2	-2	0.12016892E 07	0.12016892E 07	0.
3	1	2	2	0.21879874E 06	0.21879874E 06	0.
3	2	2	-1	0.21912992E 07	0.21912992E 07	0.
3	3	2	0	0.21768098E 07	0.21768098E 07	0.
3	-1	3	-2	0.28979344E 05	0.28979344E 05	0.
3	0	3	-3	0.98310395E 06	0.98310395E 06	0.
3	1	3	0	0.35594760E 03	0.35594760E 03	0.
3	2	3	-1	0.19510950E 07	0.19510950E 07	0.
3	3	3	-2	0.19800750E 07	0.19800750E 07	0.
3	3	3	2	0.65625658E 00	0.65625658E 00	0.
4	-4	3	-3	0.29064085E 06	0.29064085E 06	0.
4	-4	3	1	-0.69281904E 06	-0.69281904E 06	0.
4	-3	3	-2	0.28155156E 06	0.28155156E 06	0.
4	-3	3	2	-0.16985228E 07	-0.16985228E 07	0.
4	-2	3	-1	0.30086762E 06	0.30086762E 06	0.
4	-2	3	3	-0.16502280E 07	-0.16502280E 07	0.
4	-1	3	0	0.29129662E 06	0.29129662E 06	0.
4	0	3	-3	0.12754677E 07	0.12754677E 07	0.
4	0	3	1	0.29200779E 06	0.29200779E 06	0.
4	1	3	-2	0.22715668E 07	0.22715668E 07	0.
4	1	3	2	0.29149248E 06	0.29149248E 06	0.
4	2	3	-1	0.22425921E 07	0.22425921E 07	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
4	2	3	3	0.29149642E 06	0.29149642E 06	0.
4	3	3	0	0.32396514E 07	0.32396514E 07	0.
4	4	3	-3	0.42227553E 07	0.42227553E 07	0.
4	4	3	1	0.32392954E 07	0.32392954E 07	0.
4	-2	4	-3	0.48295406E 05	0.48295406E 05	0.
4	-1	4	-4	0.98375973E 06	0.98375973E 06	0.
4	0	4	-1	0.10671109E 04	0.10671109E 04	0.
4	1	4	-2	0.19417199E 07	0.19417199E 07	0.
4	2	4	-3	0.19900199E 07	0.19900199E 07	0.
4	2	4	1	0.45932412E 01	0.45932412E 01	0.
4	3	4	-4	0.39321145E 07	0.39321145E 07	0.
4	3	4	0	0.29472877E 07	0.29472877E 07	0.
4	4	4	-1	0.29483547E 07	0.29483547E 07	0.
4	4	4	3	0.50174007E-02	0.50174007E-02	0.
5	-5	4	-4	0.36277047E 06	0.36277047E 06	0.
5	-5	4	0	-0.62205636E 06	-0.62205636E 06	0.
5	-5	4	4	-0.35693440E 07	-0.35693440E 07	0.
5	-4	4	-3	0.35181029E 06	0.35181029E 06	0.
5	-4	4	1	-0.16382050E 07	-0.16382050E 07	0.
5	-3	4	-2	0.37594651E 06	0.37594651E 06	0.
5	-3	4	2	-0.15657779E 07	-0.15657779E 07	0.
5	-2	4	-1	0.36403178E 06	0.36403178E 06	0.
5	-2	4	3	-0.25843230E 07	-0.25843230E 07	0.
5	-1	4	-4	0.13502781E 07	0.13502781E 07	0.
5	-1	4	0	0.36545127E 06	0.36545127E 06	0.
5	-1	4	4	-0.25818364E 07	-0.25818364E 07	0.
5	0	4	-3	0.23544432E 07	0.23544432E 07	0.
5	0	4	1	0.36442796E 06	0.36442796E 06	0.
5	1	4	-2	0.23061662E 07	0.23061662E 07	0.
5	1	4	2	0.36444174E 06	0.36444174E 06	0.
5	2	4	-1	0.33127030E 07	0.33127030E 07	0.
5	2	4	3	0.36434825E 06	0.36434825E 06	0.
5	3	4	-4	0.42964627E 07	0.42964627E 07	0.
5	3	4	0	0.33116359E 07	0.33116359E 07	0.
5	3	4	4	0.36434829E 06	0.36434829E 06	0.
5	4	4	-3	0.62850793E 07	0.62850793E 07	0.
5	4	4	1	0.42950641E 07	0.42950641E 07	0.
5	5	4	-2	0.62367839E 07	0.62367839E 07	0.
5	5	4	2	0.42950594E 07	0.42950594E 07	0.
5	-3	5	-4	0.72431631E 05	0.72431631E 05	0.
5	-2	5	-5	0.98502103E 06	0.98502103E 06	0.
5	-1	5	-2	0.24866037E 04	0.24866037E 04	0.
5	0	5	-3	0.19302013E 07	0.19302013E 07	0.
5	1	5	-4	0.20026513E 07	0.20026513E 07	0.
5	1	5	0	0.18368628E 02	0.18368628E 02	0.
5	2	5	-5	0.39336922E 07	0.39336922E 07	0.
5	2	5	-1	0.29461846E 07	0.29461846E 07	0.
5	3	5	-2	0.29486713E 07	0.29486713E 07	0.
5	3	5	2	0.45152971E-01	0.45152971E-01	0.
5	4	5	-3	0.58608374E 07	0.58608374E 07	0.
5	4	5	1	0.39306177E 07	0.39306177E 07	0.
5	5	5	-4	0.59332691E 07	0.59332691E 07	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
5	5	5	0	0.39306361E 07	0.39306361E 07	
5	5	5	4	0.34578262E-04	0.34678262E-04	0.
6	-6	5	-5	0.43455262F 06	0.43455262F 06	0.
6	-6	5	-1	-0.55295500E 06	-0.55295500E 06	0.
6	-6	5	3	-0.34991397F 07	-0.34991397F 07	0.
6	-5	5	-4	0.42198652E 06	0.42198652E 06	0.
6	-5	5	0	-0.15806464E 07	-0.15806464E 07	0.
6	-5	5	4	-0.55112825F 07	-0.55112825E 07	0.
6	-4	5	-3	0.45092980E 06	0.45092980E 06	0.
6	-4	5	1	-0.14792899E 07	-0.14792899E 07	0.
6	-4	5	5	-0.54099076E 07	-0.54099076E 07	0.
6	-3	5	-2	0.43670765E 06	0.43670765E 06	0.
6	-3	5	2	-0.25119636E 07	-0.25119636E 07	0.
6	-2	5	-5	0.14266905E 07	0.14266905F 07	0.
6	-2	5	-1	0.43918286E 06	0.43918286E 06	0.
6	-2	5	3	-0.25070018E 07	-0.25070018E 07	0.
6	-1	5	-4	0.24400344E 07	0.24400344E 07	0.
6	-1	5	0	0.43740150E 06	0.43740150E 06	0.
6	-1	5	4	-0.34932346E 07	-0.34932346E 07	0.
6	0	5	-3	0.23676579E 07	0.23676579E 07	0.
6	0	5	1	0.43743821F 06	0.43743821F 06	0.
6	0	5	5	-0.34931795E 07	-0.34931795E 07	0.
6	1	5	-2	0.33859413E 07	0.33859413E 07	0.
6	1	5	2	0.43727007E 06	0.43727007E 06	0.
6	2	5	-5	0.43709626E 07	0.43709626E 07	0.
6	2	5	-1	0.33834549E 07	0.33834549E 07	0.
6	3	5	3	0.43727025E 06	0.43727025E 06	0.
6	3	5	-4	0.63704751E 07	0.63704751E 07	0.
6	3	5	0	0.43678421E 07	0.43678421E 07	0.
6	4	5	4	0.43720606F 06	0.43720606E 06	0.
6	4	5	-3	0.62980435E 07	0.62980435E 07	0.
6	4	5	1	0.43678238E 07	0.43678238E 07	0.
6	5	5	5	0.43720606F 06	0.43720606E 06	0.
6	5	5	-2	0.82993039E 07	0.82993039E 07	0.
6	6	5	2	0.53506327F 07	0.53506327E 07	0.
6	6	5	-5	0.92843249F 07	0.92843249E 07	0.
6	6	5	-1	0.82968173F 07	0.82968173E 07	0.
6	6	5	3	0.53506326E 07	0.53506326E 07	0.
6	-4	6	-5	0.10137491E 06	0.10137491E 06	0.
6	-3	6	-6	0.98717605E 06	0.98717605E 06	0.
6	-2	6	-3	0.49618113E 04	0.49618113E 04	0.
6	-1	6	-4	0.19166730E 07	0.19166730E 07	0.
6	0	6	-5	0.20181030E 07	0.20181030E 07	0.
6	0	6	-1	0.55083393E 02	0.55083393E 02	0.
6	1	6	-6	0.39364097F 07	0.39364097E 07	0.
6	1	6	-2	0.29442718F 07	0.29442718F 07	0.
6	2	6	-3	0.29492339E 07	0.29492339E 07	0.
6	2	6	1	0.22573344E-00	0.22573344E-00	0.
6	3	6	-4	0.58471137E 07	0.58471137F 07	0.
6	3	6	0	0.39303856E 07	0.39303856E 07	0.
6	4	6	-5	0.59484886E 07	0.59484886E 07	0.
6	4	6	-1	0.39304407E 07	0.39304407E 07	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
6	4	6	3	0.38143806E-03	0.38143806E-03	0.
6	5	6	-6	0.88497722E 07	0.88497722E 07	0.
6	5	6	-2	0.78576344E 07	0.78576344E 07	0.
6	5	6	2	0.49133624E 07	0.49133624E 07	0.
6	6	6	-3	0.78625962E 07	0.78625962E 07	0.
6	6	6	1	0.49133626E 07	0.49133626E 07	0.
6	6	6	5	0.22444874E-06	0.22444874E-06	0.
7	-7	6	-6	0.50592813E 06	0.50592813E 06	0.
7	-7	6	-2	-0.48620973E 06	-0.48620973E 06	0.
7	-7	6	2	-0.34304818E 07	-0.34304818E 07	0.
7	-7	6	6	-0.83438442E 07	-0.83438442E 07	0.
7	-6	6	-5	0.49206706E 06	0.49206706E 06	0.
7	-6	6	-1	-0.15259809E 07	-0.15259809E 07	0.
7	-6	6	3	-0.54564216E 07	-0.54564216E 07	0.
7	-5	6	-4	0.52579452E 06	0.52579452E 06	0.
7	-5	6	0	-0.13909336E 07	-0.13909336E 07	0.
7	-5	6	4	-0.53213191E 07	-0.53213191E 07	0.
7	-4	6	-3	0.50931234E 06	0.50931234E 06	0.
7	-4	6	1	-0.24399213E 07	-0.24399213E 07	0.
7	-4	6	5	-0.73532839E 07	-0.73532839E 07	0.
7	-3	6	-6	0.15053875E 07	0.15053875E 07	0.
7	-3	6	-2	0.51324961E 06	0.51324961E 06	0.
7	-3	6	2	-0.24310225E 07	-0.24310225E 07	0.
7	-3	6	6	-0.73443849E 07	-0.73443849E 07	0.
7	-2	6	-5	0.25284652E 07	0.25284652E 07	0.
7	-2	6	-1	0.51041722E 06	0.51041722E 06	0.
7	-2	6	3	-0.34200234E 07	-0.34200234E 07	0.
7	-1	6	-4	0.24272278E 07	0.24272278E 07	0.
7	-1	6	0	0.51049976E 06	0.51049976E 06	0.
7	-1	6	4	-0.34198858E 07	-0.34198858E 07	0.
7	0	6	-3	0.34594539E 07	0.34594539E 07	0.
7	0	6	1	0.51022023E 06	0.51022023E 06	0.
7	0	6	5	-0.44031424E 07	-0.44031424E 07	0.
7	1	6	-6	0.44466307E 07	0.44466307E 07	0.
7	1	6	-2	0.34544929E 07	0.34544929E 07	0.
7	1	6	2	0.51022083E 06	0.51022083E 06	0.
7	1	6	6	-0.44031416E 07	-0.44031416E 07	0.
7	2	6	-5	0.64586073E 07	0.64586073E 07	0.
7	2	6	-1	0.44405594E 07	0.44405594E 07	0.
7	2	6	3	0.51011872E 06	0.51011872E 06	0.
7	3	6	-4	0.63572324E 07	0.63572324E 07	0.
7	3	6	0	0.44405043E 07	0.44405043E 07	0.
7	3	6	4	0.51011872E 06	0.51011872E 06	0.
7	4	6	-3	0.83726617E 07	0.83726617E 07	0.
7	4	6	1	0.54234280E 07	0.54234280E 07	0.
7	4	6	5	0.51006540E 06	0.51006540E 06	0.
7	5	6	-6	0.93598377E 07	0.93598377E 07	0.
7	5	6	-2	0.83676999E 07	0.83676999E 07	0.
7	5	6	2	0.54234277E 07	0.54234277E 07	0.
7	5	6	6	0.51006540E 06	0.51006540E 06	0.
7	6	6	-5	0.12354688E 08	0.12354688E 08	0.
7	6	6	-1	0.10336640E 08	0.10336640E 08	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
7	6	6	3	0.64061992E 07	0.64061992E 07	0.
7	7	6	-4	0.12253313E 08	0.12253313E 08	0.
7	7	6	0	0.10336585E 08	0.10336585E 08	0.
7	7	6	4	0.64061992E 07	0.64061992E 07	0.
7	-5	7	-6	0.13510238E 06	0.13510238E 06	0.
7	-4	7	-7	0.99056027E 06	0.99056027E 06	0.
7	-3	7	-4	0.88990751E 04	0.88990751E 04	0.
7	-2	7	-5	0.19012957E 07	0.19012957E 07	0.
7	-1	7	-6	0.20365357E 07	0.20365357E 07	0.
7	-1	7	-2	0.13761911E 03	0.13761911E 03	0.
7	0	7	-7	0.39407018E 07	0.39407018E 07	0.
7	0	7	-3	0.29412425E 07	0.29412425E 07	0.
7	1	7	-4	0.29501424E 07	0.29501424E 07	0.
7	1	7	0	0.82750633E 00	0.82750633E 00	0.
7	2	7	-5	0.58314379E 07	0.58314379E 07	0.
7	2	7	-1	0.39300045E 07	0.39300045E 07	0.
7	3	7	-6	0.59665402E 07	0.59665402E 07	0.
7	3	7	-2	0.39301422E 07	0.39301422E 07	0.
7	3	7	2	0.22883965E-02	0.22883965E-02	0.
7	4	7	-7	0.88539096E 07	0.88539096E 07	0.
7	4	7	-3	0.78544502E 07	0.78544502E 07	0.
7	4	7	1	0.49132069E 07	0.49132069E 07	0.
7	5	7	-4	0.78633493E 07	0.78633493E 07	0.
7	5	7	0	0.49132077E 07	0.49132077E 07	0.
7	5	7	4	0.29243529E-05	0.29243529E-05	0.
7	6	7	-5	0.11727518E 08	0.11727518E 08	0.
7	6	7	-1	0.98260850E 07	0.98260850E 07	0.
7	6	7	3	0.58960804E 07	0.58960804E 07	0.
7	7	7	-6	0.11862621E 08	0.11862621E 08	0.
7	7	7	-2	0.98262226E 07	0.98262226E 07	0.
7	7	7	2	0.58960805E 07	0.58960805E 07	0.
7	7	7	6	0.18626451E-08	0.18626451E-08	0.
8	-8	7	-7	0.57684827E 06	0.57684827E 06	0.
8	-8	7	-3	-0.42261107E 06	-0.42261107E 06	0.
8	-8	7	1	-0.33638544E 07	-0.33638544E 07	0.
8	-8	7	5	-0.82770613E 07	-0.82770613E 07	0.
8	-7	7	-6	0.56204080E 06	0.56204080E 06	0.
8	-7	7	-2	-0.14743573E 07	-0.14743573E 07	0.
8	-7	7	2	-0.54044994E 07	-0.54044994E 07	0.
8	-7	7	6	-0.11300580E 08	-0.11300580E 08	0.
8	-6	7	-5	0.60051595E 06	0.60051595E 06	0.
8	-6	7	-1	-0.13009174E 07	-0.13009174E 07	0.
8	-6	7	3	-0.52309219E 07	-0.52309219E 07	0.
8	-6	7	7	-0.11127002E 08	-0.11127002E 08	0.
8	-5	7	-4	0.58183428E 06	0.58183428E 06	0.
8	-5	7	0	-0.23683072E 07	-0.23683072E 07	0.
8	-5	7	4	-0.72815151E 07	-0.72815151E 07	0.
8	-4	7	-7	0.15871477E 07	0.15871477E 07	0.
8	-4	7	-3	0.58768836E 06	0.58768836E 06	0.
8	-4	7	1	-0.23535549E 07	-0.23535549E 07	0.
8	-4	7	5	-0.72667619E 07	-0.72667619E 07	0.
8	-3	7	-6	0.26198755E 07	0.26198755E 07	0.

60

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
8	-3	7	-2	0.58347745E 06	0.58347745E 06	0.
8	-3	7	2	-0.33466647E 07	-0.33466647E 07	0.
8	-3	7	6	-0.92427451E 07	-0.92427451E 07	0.
8	-2	7	-5	0.24850756E 07	0.24850756E 07	0.
8	-2	7	-1	0.58364230E 06	0.58364230E 06	0.
8	-2	7	3	-0.33463622E 07	-0.33463622E 07	0.
8	-2	7	7	-0.92424427E 07	-0.92424427E 07	0.
8	-1	7	-4	0.35333449E 07	0.35333449E 07	0.
8	-1	7	0	0.58320338E 06	0.58320338E 06	0.
8	-1	7	4	-0.43300044E 07	-0.43300044E 07	0.
8	0	7	-7	0.45239077E 07	0.45239077E 07	0.
8	0	7	-3	0.35244483E 07	0.35244483E 07	0.
8	0	7	1	0.58320504E 06	0.58320504E 06	0.
8	0	7	5	-0.43300019E 07	-0.43300019E 07	0.
8	1	7	-6	0.65495924E 07	0.65495924E 07	0.
8	1	7	-2	0.45131943E 07	0.45131943E 07	0.
8	1	7	2	0.58305218E 06	0.58305218E 06	0.
8	1	7	6	-0.53130283E 07	-0.53130283E 07	0.
8	2	7	-5	0.64144901E 07	0.64144901E 07	0.
8	2	7	-1	0.45130567E 07	0.45130567E 07	0.
8	2	7	3	0.58305219E 06	0.58305219E 06	0.
8	2	7	7	-0.53130282E 07	-0.53130282E 07	0.
8	3	7	-4	0.84463219E 07	0.84463219E 07	0.
8	3	7	0	0.54961804E 07	0.54961804E 07	0.
8	3	7	4	0.58297259E 06	0.58297259E 06	0.
8	4	7	-7	0.94368821E 07	0.94368821E 07	0.
8	4	7	-3	0.84374229E 07	0.84374229E 07	0.
8	4	7	1	0.54961796E 07	0.54961796E 07	0.
8	4	7	5	0.58297259E 06	0.58297259E 06	0.
8	5	7	-6	0.12445546E 08	0.12445546E 08	0.
8	5	7	-2	0.10409148E 08	0.10409148E 08	0.
8	5	7	2	0.64790061E 07	0.64790061E 07	0.
8	5	7	6	0.58292556E 06	0.58292556E 06	0.
8	6	7	-5	0.12310444E 08	0.12310444E 08	0.
8	6	7	-1	0.10409011E 08	0.10409011E 08	0.
8	6	7	3	0.64790061E 07	0.64790061E 07	0.
8	6	7	7	0.58292556E 06	0.58292556E 06	0.
8	7	7	-4	0.15325113E 08	0.15325113E 08	0.
8	7	7	0	0.12374972E 08	0.12374972E 08	0.
8	7	7	4	0.74617640E 07	0.74617640E 07	0.
8	8	7	-7	0.16315674E 08	0.16315674E 08	0.
8	8	7	-3	0.15316214E 08	0.15316214E 08	0.
8	8	7	1	0.12374971E 08	0.12374971E 08	0.
8	8	7	5	0.74617640E 07	0.74617640E 07	0.
8	-6	8	-7	0.17357752E 06	0.17357752E 06	0.
8	-5	8	-8	0.99554629E 06	0.99554629E 06	0.
8	-4	8	-5	0.14753154E 05	0.14753154E 05	0.
8	-3	8	-6	0.18842572E 07	0.18842572E 07	0.
8	-2	8	-7	0.20581372E 07	0.20581372E 07	0.
8	-2	8	-3	0.30246813E 03	0.30246813E 03	0.
8	-1	8	-8	0.39470569E 07	0.39470569E 07	0.
8	-1	8	-4	0.29367575E 07	0.29367575E 07	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
9	0	8	-5	0.29515131E 07	0.29515131E 07	0.
8	0	8	-1	0.24816997E 01	0.24816997E 01	0.
9	1	8	-6	0.58139741E 07	0.58139741E 07	0.
8	1	8	-2	0.39294144E 07	0.39294144E 07	0.
9	2	8	-7	0.59875516E 07	0.59875516E 07	0.
8	2	8	-3	0.39297169E 07	0.39297169E 07	0.
8	2	8	1	0.99148965E-02	0.99148965E-02	0.
9	3	9	-8	0.88600339E 07	0.88600339E 07	0.
8	3	8	4	0.78497345E 07	0.78497345E 07	0.
8	3	8	0	0.49129745E 07	0.49129745E 07	0.
9	4	8	-5	0.78644876E 07	0.78644876E 07	0.
8	4	8	-1	0.49129770E 07	0.49129770E 07	0.
9	4	8	3	0.20471402E-04	0.20471402E-04	0.
8	5	8	-6	0.11709928E 08	0.11709928E 08	0.
8	5	8	-2	0.98253682E 07	0.98253682E 07	0.
8	5	8	2	0.58959538E 07	0.58959538E 07	0.
8	6	8	-7	0.11883505E 08	0.11883505E 08	0.
8	6	8	-3	0.98256707E 07	0.98256707E 07	0.
9	6	8	1	0.58959539E 07	0.58959539E 07	0.
8	6	8	5	0.20489097E-07	0.20489097E-07	0.
8	7	8	-8	0.15738825E 08	0.15738825E 08	0.
8	7	8	-4	0.14728526E 08	0.14728526E 08	0.
8	7	8	0	0.11791766E 08	0.11791766E 08	0.
8	7	8	4	0.68787914E 07	0.68787914E 07	0.
8	8	8	-5	0.14743279E 08	0.14743279E 08	0.
8	8	8	-1	0.11791768E 08	0.11791768E 08	0.
8	8	8	3	0.68787914E 07	0.68787914E 07	0.
8	8	8	7	0.	-0.	0.

BENZONITRILE RIGID ROTOR TRANSITION FREQUENCIES

Input Coefficients

A = 0.56553500E 04 μ = 4.14
B = 0.15458900E 04
C = 0.12144300E 04

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
1	-1	-0	0	0.27613100E 04	0.27613100E 04	0.
1	1	1	0	0.33245000E 03	0.33245000E 03	0.
2	-2	1	-1	0.55032506E 04	0.55032506F 04	0.
2	-1	1	0	0.51901700E 04	0.51901700E 04	0.
2	0	1	1	0.58550701E 04	0.58550701E 04	0.
2	2	1	-1	0.22640759E 05	0.22640769E 05	0.
2	0	2	-1	0.99735002E 03	0.99735002E 03	0.
2	1	2	-2	0.17118149E 05	0.17118149E 05	0.
2	2	2	1	0.19369443E 02	0.19369443E 02	0.
2	-3	2	-2	0.82068851E 04	0.82068861E 04	0.
3	-3	2	2	-0.89306326E 04	-0.89306326E 04	0.
3	-2	2	-1	0.77734828E 04	0.77734828E 04	0.
3	-1	2	0	0.87701261E 04	0.87701261E 04	0.
3	0	2	1	0.82839301E 04	0.82839301E 04	0.
3	1	2	-2	0.25498493E 05	0.25498493E 05	0.
3	1	2	2	0.83609739E 04	0.83609739E 04	0.
3	2	2	-1	0.42991937E 05	0.42991937E 05	0.
3	3	2	0	0.41995293E 05	0.41995293E 05	0.
3	-1	3	-2	0.19939933E 04	0.19939933E 04	0.
3	0	3	-3	0.17195193E 05	0.17195193E 05	0.
3	1	3	0	0.96413285E 02	0.96413285E 02	0.
3	2	3	-1	0.33224460E 05	0.33224460E 05	0.
3	3	3	-2	0.35219151E 05	0.35219151E 05	0.
3	3	3	2	0.70677067E 00	0.70677067E 00	0.
4	-4	3	-3	0.10855386E 05	0.10855386E 05	0.
4	-4	3	1	-0.64362198E 04	-0.64362198E 04	0.
4	-3	3	-2	0.10343635E 05	0.10343635E 05	0.
4	-3	3	2	-0.24874819E 05	-0.24874819E 05	0.
4	-2	3	-1	0.11669204E 05	0.11669204E 05	0.
4	-2	3	3	-0.21555964E 05	-0.21555964E 05	0.
4	-1	3	0	0.11030162E 05	0.11030162E 05	0.
4	0	3	-3	0.28511601E 05	0.28511601E 05	0.
4	0	3	1	0.11219994E 05	0.11219994E 05	0.
4	1	3	-2	0.46300399E 05	0.46300399E 05	0.
4	1	3	2	0.11081945E 05	0.11081945E 05	0.
4	2	3	-1	0.44311344E 05	0.44311344E 05	0.

63

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
4	2	3	3	0.11086176E 05	0.11086176E 05	0.
4	1	3	0	0.62356657E 05	0.62356657E 05	0.
4	4	3	-3	0.79551871E 05	0.79551871E 05	0.
4	4	3	1	0.62260255E 05	0.62260265E 05	0.
4	-2	4	-3	0.33195620E 04	0.33195620E 04	0.
4	-1	4	-4	0.17369969E 05	0.17369969E 05	0.
4	0	4	-1	0.28624530E 03	0.28624530E 03	0.
4	1	4	-2	0.32637202E 05	0.32637202E 05	0.
4	2	4	-4	0.35961702E 05	0.35961702E 05	0.
4	2	4	1	0.49380102E 01	0.49380102E 01	0.
4	3	4	-4	0.68696454E 05	0.68696464E 05	0.
4	3	4	0	0.51040250E 05	0.51040250E 05	0.
4	4	4	-1	0.51326516E 05	0.51326515E 05	0.
4	4	4	3	0.21387240E-01	0.21387240E-01	0.
5	-5	4	-4	0.13437572E 05	0.13437572E 05	0.
5	-5	4	0	-0.42186423E 04	-0.42186423E 04	0.
5	-5	4	4	-0.55258913E 05	-0.55258913E 05	0.
5	-4	4	-3	0.12897780E 05	0.12897780E 05	0.
5	-4	4	1	-0.23058984E 05	-0.23058984E 05	0.
5	-3	4	-2	0.14545289E 05	0.14545289E 05	0.
5	-3	4	2	-0.18096851E 05	-0.18096851E 05	0.
5	-2	4	-1	0.13763520E 05	0.13763520E 05	0.
5	-2	4	3	-0.37562975E 05	-0.37562975E 05	0.
5	-1	4	-4	0.31788541E 05	0.31788541E 05	0.
5	-1	4	0	0.14132327E 05	0.14132327E 05	0.
5	-1	4	4	-0.36907944E 05	-0.36907944E 05	0.
5	0	4	-3	0.49822773E 05	0.49822773E 05	0.
5	0	4	1	0.13866009E 05	0.13866009E 05	0.
5	1	4	-2	0.46522889E 05	0.46522889E 05	0.
5	1	4	2	0.13880749E 05	0.13880749E 05	0.
5	2	4	-1	0.65176076E 05	0.65176076E 05	0.
5	2	4	3	0.13849581E 05	0.13849581E 05	0.
5	3	4	-4	0.82546236E 05	0.82546236E 05	0.
5	3	4	0	0.64890022E 05	0.64890022E 05	0.
5	3	4	4	0.13849751E 05	0.13849751E 05	0.
5	4	4	-3	0.11912814E 06	0.11812814E 06	0.
5	4	4	1	0.82171378E 05	0.82171378E 05	0.
5	5	4	-2	0.11480858E 06	0.11480858E 06	0.
5	5	4	2	0.82166440E 05	0.82166440E 05	0.
5	-3	5	-4	0.49670710E 04	0.49670710E 04	0.
5	-2	5	-5	0.17695917E 05	0.17695917E 05	0.
5	-1	5	-2	0.65505257E 03	0.65505257E 03	0.
5	0	5	-3	0.31957922E 05	0.31957922E 05	0.
5	1	5	-4	0.36944671E 05	0.36944671E 05	0.
5	1	5	0	0.19678451E 02	0.19678451E 02	0.
5	2	5	-5	0.69108473E 05	0.69108473E 05	0.
5	2	5	-1	0.50757503E 05	0.50757503E 05	0.
5	3	5	-2	0.51412748E 05	0.51412748E 05	0.
5	3	5	2	0.19224224E-00	0.19224224E-00	0.
5	4	5	-3	0.10026329E 06	0.10026329E 06	0.
5	4	5	1	0.58285690E 05	0.68285690E 05	0.
5	5	5	-4	0.10523036E 06	0.10523036E 06	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
5	5	5	0	0.68305369E 05	0.68305369E 05	0.
5	5	5	4	0.58502278E-03	0.58502278E-03	0.
5	-6	5	-5	0.15952209E 05	0.15952209E 05	0.
5	-5	5	-1	-0.23987608E 04	-0.23987608E 04	0.
5	-6	5	3	-0.53156456E 05	-0.53156456E 05	0.
5	-5	5	-4	0.15434231E 05	0.15434231E 05	0.
5	-5	5	0	-0.21490762E 05	-0.21490762E 05	0.
5	-5	5	4	-0.89796131E 05	-0.89796131E 05	0.
5	-4	5	-3	0.17389952E 05	0.17389952E 05	0.
5	-4	5	1	-0.14587648E 05	-0.14587648E 05	0.
5	-4	5	5	-0.82873340E 05	-0.82873340E 05	0.
5	-3	5	-2	0.16480905E 05	0.16480905E 05	0.
5	-3	5	2	-0.34931650E 05	-0.34931650E 05	0.
5	-2	5	-5	0.35446759E 05	0.35446759E 05	0.
5	-2	5	-1	0.17095790E 05	0.17095790E 05	0.
5	-2	5	3	-0.33661906E 05	-0.33661906E 05	0.
5	-1	5	-4	0.53580634E 05	0.53580634E 05	0.
5	-1	5	0	0.16655641E 05	0.16655641E 05	0.
5	-1	5	4	-0.51649728E 05	-0.51649728E 05	0.
5	0	5	-3	0.48672214E 05	0.48672214E 05	0.
5	0	5	1	0.16694614E 05	0.16694614E 05	0.
5	0	5	5	-0.51591077E 05	-0.51591077E 05	0.
5	1	5	-2	0.68046031E 05	0.68046031E 05	0.
5	1	5	2	0.16633475E 05	0.16633475E 05	0.
5	2	5	-5	0.85742907E 05	0.85742907E 05	0.
5	2	5	-1	0.67391937E 05	0.67391937E 05	0.
5	2	5	3	0.16634242E 05	0.16634242E 05	0.
5	3	5	-4	0.12184672E 06	0.12184672E 06	0.
5	3	5	0	0.84921727E 05	0.84921727E 05	0.
5	3	5	4	0.16616358E 05	0.16616358E 05	0.
5	4	5	-3	0.11687956E 06	0.11697966E 06	0.
5	4	5	1	0.84902055E 05	0.84902055E 05	0.
5	4	5	5	0.16616354E 05	0.16616364E 05	0.
5	5	5	-2	0.15343754E 06	0.15343754E 05	0.
5	5	5	2	0.10202499E 06	0.10202499E 06	0.
5	6	5	-5	0.17113366E 06	0.17113366E 06	0.
5	6	5	-1	0.15278249E 06	0.15278249E 06	0.
5	6	5	3	0.10202480E 06	0.10202480E 06	0.
5	-4	6	-5	0.69227924E 04	0.69227924E 04	0.
5	-3	6	-4	0.19224614E 05	0.19224614E 05	0.
5	-3	6	-3	0.12699370E 04	0.12699370E 04	0.
5	-1	6	-4	0.31223611E 05	0.31223611E 05	0.
5	0	6	-5	0.38205055E 05	0.38205055E 05	0.
5	0	6	-1	0.58651265E 02	0.58651265E 02	0.
5	1	6	-6	0.69787739E 05	0.69787739E 05	0.
5	1	6	-2	0.50295189E 05	0.50295189E 05	0.
5	2	6	-3	0.51566085E 05	0.51566085E 05	0.
5	2	6	1	0.35911147E 00	0.35911147E 00	0.
5	3	6	-4	0.99489496E 05	0.99489496E 05	0.
5	3	6	0	0.68207435E 05	0.68207435E 05	0.
5	4	6	-5	0.10641250E 06	0.10641250E 06	0.
5	4	6	-1	0.68266092E 05	0.68266092E 05	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
6	5	6	3	0.64288576E-02	0.64288576E-02	0.
6	5	6	-6	0.15518125E 06	0.15518125E 06	0.
6	5	6	-2	0.13569670E 06	0.13569670E 06	0.
6	5	6	2	0.85390554E 05	0.85390554E 05	0.
6	6	6	-3	0.13695664E 06	0.13695664E 06	0.
6	6	6	1	0.85391514E 05	0.85391514E 05	0.
6	7	6	5	0.15020662E-04	0.15020662E-04	0.
7	-7	6	-6	0.18409735E 05	0.18409735E 05	0.
7	-7	6	-2	-0.10848152E 04	-0.10848152E 04	0.
7	-7	6	2	-0.51380963E 05	-0.51380963E 05	0.
7	-7	6	6	-0.13677152E 06	-0.13677152E 06	0.
7	-6	6	-5	0.17952525E 05	0.17952525E 05	0.
7	-6	6	-1	-0.20193878E 05	-0.20193878E 05	0.
7	-6	6	3	-0.88459964E 05	-0.88459964E 05	0.
7	-5	6	-4	0.20193206E 05	0.20193206E 05	0.
7	-5	6	0	-0.11089056E 05	-0.11089056E 05	0.
7	-5	6	4	-0.79296497E 05	-0.79296497E 05	0.
7	-4	6	-3	0.19179400E 05	0.19179400E 05	0.
7	-4	6	1	-0.32385726E 05	-0.32385726E 05	0.
7	-4	6	5	-0.11777724E 06	-0.11777724E 06	0.
7	-3	6	-5	0.39590840E 05	0.39590840E 05	0.
7	-3	6	-2	0.20096289E 05	0.20096289E 05	0.
7	-3	6	2	-0.30199859E 05	-0.30199859E 05	0.
7	-3	6	6	-0.11559041E 06	-0.11559041E 06	0.
7	-2	6	-5	0.57595284E 05	0.57595284E 05	0.
7	-2	6	-1	0.19448880E 05	0.19448880E 05	0.
7	-2	6	3	-0.48817205E 05	-0.48817205E 05	0.
7	-1	6	-4	0.50817580E 05	0.50817580E 05	0.
7	-1	6	0	0.19535317E 05	0.19535317E 05	0.
7	-1	6	4	-0.48672124E 05	-0.48672124E 05	0.
7	0	6	-3	0.70989748E 05	0.70989748E 05	0.
7	0	6	1	0.19424623E 05	0.19424623E 05	0.
7	0	6	5	-0.65966891E 05	-0.65966891E 05	0.
7	1	6	-6	0.89217856E 05	0.89217856E 05	0.
7	1	6	-2	0.69723316E 05	0.69723316E 05	0.
7	1	6	2	0.19427168E 05	0.19427168E 05	0.
7	1	6	6	-0.65963386E 05	-0.65963386E 05	0.
7	2	6	-5	0.12581050E 06	0.12581050E 06	0.
7	2	6	-1	0.87664100E 05	0.87664100E 05	0.
7	2	6	3	0.19398014E 05	0.19398014E 05	0.
7	3	6	-4	0.11888775E 06	0.11888775E 06	0.
7	3	6	0	0.87605486E 05	0.87605486E 05	0.
7	3	6	4	0.19398046E 05	0.19398046E 05	0.
7	4	6	-3	0.15634013E 06	0.15634013E 06	0.
7	4	6	1	0.10477500E 06	0.10477500E 06	0.
7	4	6	5	0.19383489E 05	0.19383489E 05	0.
7	5	6	-6	0.17456474E 06	0.17456474E 06	0.
7	5	6	-2	0.15507019E 06	0.15507019E 06	0.
7	5	6	2	0.10477404E 06	0.10477404E 06	0.
7	5	6	6	0.19383490E 05	0.19383490E 05	0.
7	6	6	-5	0.22829217E 06	0.22829217E 06	0.
7	6	6	-1	0.19014577E 06	0.19014577E 06	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
7	6	6	3	0.12187968E 06	0.12187968E 06	0.
7	7	6	-4	0.22136938E 06	0.22136938E 06	0.
7	7	6	0	0.19008712E 06	0.19008712E 06	0.
7	7	6	4	0.12187968E 06	0.12187968E 06	0.
7	-5	7	-6	0.91634735E 04	0.91634735E 04	0.
7	-4	7	-7	0.18994278E 05	0.18994278E 05	0.
7	-3	7	-4	0.21868267E 04	0.21868267E 04	0.
7	-2	7	-5	0.30479285E 05	0.30479285E 05	0.
7	-1	7	-6	0.39787847E 05	0.39787847E 05	0.
7	-1	7	-2	0.14508826E 03	0.14508826E 03	0.
7	0	7	-7	0.70804627E 05	0.70804627E 05	0.
7	0	7	-3	0.49623522E 05	0.49623522E 05	0.
7	1	7	-4	0.51813954E 05	0.51813954E 05	0.
7	1	7	0	0.35045112E 01	0.35045112E 01	0.
7	2	7	-5	0.98694504E 05	0.98694504E 05	0.
7	2	7	-1	0.68070131E 05	0.68070131E 05	0.
7	3	7	-6	0.10785802E 06	0.10785802E 06	0.
7	3	7	-2	0.68215257E 05	0.68215257E 05	0.
7	3	7	2	0.38512257E-01	0.38512257E-01	0.
7	4	7	-7	0.15615501E 06	0.15615501E 06	0.
7	4	7	-3	0.13497390E 06	0.13497390E 06	0.
7	4	7	1	0.85346876E 05	0.85346876E 05	0.
7	5	7	-4	0.13716073E 06	0.13716073E 06	0.
7	5	7	0	0.85350380E 05	0.85350380E 05	0.
7	5	7	4	0.19510322E-03	0.19510322E-03	0.
7	6	7	-5	0.20117617E 06	0.20117617E 06	0.
7	6	7	-1	0.17055180E 06	0.17055180E 06	0.
7	6	7	3	0.10248163E 06	0.10248163E 06	0.
7	7	7	-6	0.21033965E 06	0.21033965E 06	0.
7	7	7	-2	0.17069689E 06	0.17069689E 06	0.
7	7	7	2	0.10248167E 06	0.10248167E 06	0.
7	7	7	6	0.36926940E-06	0.36926940E-06	0.
8	-8	7	-7	0.20828632E 05	0.20828632E 05	0.
8	-8	7	-3	-0.35247214E 03	-0.35247214E 03	0.
8	-8	7	1	-0.49979499E 05	-0.49979499E 05	0.
8	-8	7	5	-0.13532637E 06	-0.13532637E 06	0.
8	-7	7	-6	0.20453332E 05	0.20453332E 05	0.
8	-7	7	-2	-0.19189427E 05	-0.19189427E 05	0.
8	-7	7	2	-0.87404646E 05	-0.87404646E 05	0.
8	-7	7	6	-0.18988631E 06	-0.18988631E 06	0.
8	-6	7	-5	0.22943812E 05	0.22943812E 05	0.
8	-6	7	-1	-0.76805614E 04	-0.76805614E 04	0.
8	-6	7	3	-0.75750730E 05	-0.75750730E 05	0.
8	-6	7	7	-0.17823236E 06	-0.17823236E 06	0.
8	-5	7	-4	0.21856372E 05	0.21856372E 05	0.
8	-5	7	0	-0.29953977E 05	-0.29953977E 05	0.
8	-5	7	4	-0.11530436E 06	-0.11530436E 06	0.
8	-4	7	-7	0.44292370E 05	0.44292370E 05	0.
8	-4	7	-3	0.23111265E 05	0.23111265E 05	0.
8	-4	7	1	-0.26515762E 05	-0.26515762E 05	0.
8	-4	7	5	-0.11186264E 06	-0.11186264E 06	0.
8	-3	7	-6	0.51885390E 05	0.51885390E 05	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
9	-3	7	-2	0.22242631E 05	0.22242631E 05	0.
9	-3	7	2	-0.45972588E 05	-0.45972588E 05	0.
9	-3	7	6	-0.14845426E 06	-0.14845426E 06	0.
9	-2	7	-5	0.53035996E 05	0.53035996E 05	0.
9	-2	7	-1	0.22411622E 05	0.22411622E 05	0.
9	-2	7	3	-0.45658547E 05	-0.45658547E 05	0.
9	-2	7	7	-0.14814018E 06	-0.14814018E 06	0.
9	-1	7	-4	0.74034053E 05	0.74034053E 05	0.
9	-1	7	0	0.22223704E 05	0.22223704E 05	0.
9	-1	7	4	-0.63126676E 05	-0.63126676E 05	0.
9	0	7	-7	0.93038789E 05	0.93038789E 05	0.
9	0	7	-3	0.71857685E 05	0.71857685E 05	0.
9	0	7	1	0.22230658E 05	0.22230658E 05	0.
9	0	7	5	-0.63116218E 05	-0.63115218E 05	0.
9	1	7	-6	0.13004330E 06	0.13004330E 06	0.
9	1	7	-2	0.90400544E 05	0.90400543E 05	0.
9	1	7	2	0.22185325E 05	0.22185325E 05	0.
9	1	7	6	-0.80296344E 05	-0.80296344E 05	0.
9	2	7	-5	0.12088000E 06	0.12088000E 06	0.
9	2	7	-1	0.90255622E 05	0.90255622E 05	0.
9	2	7	3	0.22185453E 05	0.22185453E 05	0.
9	2	7	7	-0.80296177E 05	-0.80296177E 05	0.
9	3	7	-4	0.15932438E 06	0.15932438E 06	0.
9	3	7	0	0.10751403E 06	0.10751403E 06	0.
9	3	7	4	0.22163653E 05	0.22163653E 05	0.
9	4	7	-7	0.17831866E 06	0.17831866E 06	0.
9	4	7	-3	0.15713756E 06	0.15713756E 06	0.
9	4	7	1	0.10751033E 06	0.10751053E 06	0.
9	4	7	5	0.22163654E 05	0.22163654E 05	0.
9	5	7	-6	0.23249048E 06	0.23249068E 06	0.
9	5	7	-2	0.19284772E 06	0.19284772E 06	0.
9	5	7	2	0.12463255E 06	0.12463250E 06	0.
9	5	7	6	0.20150834E 05	0.20150834E 05	0.
9	6	7	-5	0.22332701E 06	0.22332701E 06	0.
9	6	7	-1	0.19270263E 06	0.19270263E 06	0.
9	6	7	3	0.12463246E 06	0.12463246E 06	0.
9	6	7	7	0.22150834E 05	0.22150834E 05	0.
9	7	7	-4	0.27889472E 06	0.27889472E 06	0.
9	7	7	0	0.22708437E 06	0.22708437E 06	0.
9	7	7	4	0.14173399E 06	0.14173399E 06	0.
9	8	7	-7	0.29788900E 06	0.29788900E 06	0.
9	8	7	-3	0.27670789E 06	0.27670789E 06	0.
9	8	7	1	0.22708087E 06	0.22708087E 06	0.
9	8	7	5	0.14173399E 06	0.14173399E 06	0.
9	-6	8	-7	0.11653954E 05	0.11653954E 05	0.
9	-5	8	-8	0.20022018E 05	0.20022018E 05	0.
9	-4	8	-5	0.34417193E 04	0.34417193E 04	0.
9	-3	8	-6	0.29778104E 05	0.29778104E 05	0.
9	-2	8	-7	0.41746139E 05	0.41746139E 05	0.
9	-2	8	-3	0.31407985E 03	0.31407985E 03	0.
9	-1	8	-8	0.72199698E 05	0.72199698E 05	0.
9	-1	8	-4	0.48735961E 05	0.48735961E 05	0.

58

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
8	0	8	-5	0.52188139E 05	0.52188139E 05	0.
9	0	8	-1	0.10458674E 02	0.10458674E 02	0.
8	1	9	-6	0.97936018E 05	0.97936018E 05	0.
9	1	8	-2	0.67843833E 05	0.67843833E 05	0.
8	2	8	-7	0.10959014E 06	0.10959014E 06	0.
9	2	9	-3	0.68158079E 05	0.68158079E 05	0.
9	2	8	1	0.16649274E-00	0.16649274E-00	0.
9	3	8	-8	0.15749003E 06	0.15749003E 06	0.
9	3	8	-4	0.13402629E 06	0.13402629E 06	0.
9	3	8	0	0.85279870E 05	0.85279870E 05	0.
8	4	8	-5	0.13746801E 06	0.13746801E 06	0.
9	4	8	-1	0.85290331E 05	0.85290331E 05	0.
8	4	9	3	0.13639941E-02	0.13639941E-02	0.
9	5	8	-6	0.20038320E 06	0.20038320E 06	0.
8	5	8	-2	0.17029101E 06	0.17029101E 06	0.
9	5	8	2	0.10244701E 06	0.10244701E 06	0.
9	6	8	-7	0.21203715E 06	0.21203715E 06	0.
9	6	8	-3	0.17060509E 06	0.17060509E 06	0.
9	6	8	1	0.10244718E 06	0.10244718E 06	0.
8	6	8	5	0.55347627E-05	0.55347627E-05	0.
9	7	9	-8	0.27706037E 06	0.27706037E 06	0.
8	7	8	-4	0.25359663E 06	0.25359663E 06	0.
9	7	8	0	0.20485021E 06	0.20485021E 06	0.
8	7	8	4	0.11957034E 06	0.11957034E 06	0.
8	8	8	-5	0.25703835E 06	0.25703835E 06	0.
8	8	8	-1	0.20486067E 06	0.20486067E 06	0.
9	8	8	3	0.11957034E 06	0.11957034E 06	0.
8	8	8	7	0.87893568E-08	0.87893568E-08	0.

NITROSYL CHLORIDE RIGID ROTOR TRANSITION FREQUENCIES

Input Coefficients

$\mu_a = 1.28$ $\mu = 1.83$

A = 0.85290000E 05 $\mu_b =$

B = 0.57393000E 04   K = -0.9909

C = 0.53764000E 04 $\mu_c = 0$

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
1	-1	-0	0	0.11114700E 05	0.11114700E 05	0.
1	0	-0	0	0.90666399E 05	0.90666399E 05	0.
1	1	1	-1	0.79913600E 05	0.799136C0E 05	0.
1	1	1	0	0.36189996E 03	0.36189996E C3	0.
2	-2	1	-1	0.22228168E 05	0.22228169E 05	0.
2	-2	1	0	-0.57323531E 05	-0.57323531E 05	0.
2	-1	1	-1	0.10141920E 06	0.10141920E 06	0.
2	-1	1	0	0.21867500E 05	0.21867500E 05	0.
2	0	1	1	0.22591300E 05	0.22591300E 05	0.
2	1	1	1	0.26124640E 06	0.26124640E 06	0.
2	2	1	-1	0.34116123E 06	0.34116123E 06	0.
2	2	1	0	0.26160953E 06	0.26160953E 06	0.
2	0	2	-2	0.80276731E 05	0.80276731E 05	0.
2	0	2	-1	0.10856999E 04	0.10856999E 04	0.
2	1	2	-2	0.31893183E 06	0.31893183E 06	0.
2	1	2	-1	0.23974080E 06	0.23974080E 06	0.
2	2	2	0	0.23865633E 06	0.23865633E 06	0.
2	2	2	1	0.12319712E 01	0.12319712E 01	0.
3	-3	2	-2	0.33339172E 05	0.33339172E 05	0.
3	-3	2	-1	-0.45851859E 05	-0.45851859E 05	0.
3	-3	2	2	-0.28559389E 06	-0.28559389E 06	0.
3	-2	2	-2	0.11199151E 06	0.11199151E 06	0.
3	-2	2	-1	0.32800481E 05	0.32800481E 05	0.
3	-2	2	2	-0.20694155E 06	-0.20694155E 06	0.
3	-1	2	0	0.33886179E 05	0.33886179E 05	0.
3	-1	2	1	-0.20476892E 06	-0.20476892E 06	0.
3	0	2	0	0.27199920E 06	0.27199920E 06	0.
3	0	2	1	0.33344100E 05	0.33344100E 05	0.
3	1	2	-2	0.35228209E 06	0.35228209E 06	0.
3	1	2	-1	0.27309106E 06	0.27309106E 06	0.
3	1	2	2	0.33349028E 05	0.33349028E 05	0.
3	2	2	-2	0.75093995E 06	0.75093995E 06	0.
3	2	2	-1	0.67174891E 06	0.67174891E 06	0.
3	2	2	2	0.43200688E 06	0.43200688E 06	0.
3	3	2	0	0.67066321E 06	0.67066321E 06	0.
3	3	2	1	0.43200811E 06	0.43200811E 06	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
3	-1	3	-3	0.80823738E 05	0.80823738E 05	0.
3	-1	3	-2	0.21713971E 04	0.21713971E 04	0.
3	0	3	-3	0.31893676E 06	0.31893676E 06	0.
3	0	3	-2	0.24028442E 06	0.24028442E 06	0.
3	1	3	-1	0.23811918E 06	0.23811918E 06	0.
3	1	3	0	0.61597592E 01	0.61597592E 01	0.
3	2	3	-1	0.63677703E 06	0.63677703E 06	0.
3	2	3	0	0.39866401E 06	0.39866401E 06	0.
3	3	3	-3	0.71760077E 06	0.71760077E 06	0.
3	3	3	-2	0.63894843E 06	0.63894843E 06	0.
3	3	3	1	0.39865786E 06	0.39865786E 06	0.
3	3	3	2	0.26211719E-02	0.26211719E-02	0.
4	-4	3	-3	0.44446481E 05	0.44446481E 05	0.
4	-4	3	-2	-0.34205859E 05	-0.34205859E 05	C.
4	-4	3	1	-0.27449644E 06	-0.27449644E 06	0.
4	-4	3	2	-0.67315429E 06	-0.67315429E 06	0.
4	-3	3	-3	0.12238489E 06	0.12238489E 06	0.
4	-3	3	-2	0.43732549E 05	0.43732549E 05	0.
4	-3	3	1	-0.19655803E 06	-0.19655803E 06	0.
4	-3	3	2	-0.59521588E 06	-0.59521588E 06	0.
4	-2	3	-1	0.45180133E 05	0.45180133E 05	0.
4	-2	3	0	-0.19293289E 06	-0.19293289E 06	0.
4	-2	3	3	-0.59159690E 06	-0.59159690E 06	0.
4	-1	3	-1	0.28257086E 06	0.28257086E 06	0.
4	-1	3	0	0.44457842E 05	0.44457842E 05	0.
4	-1	3	3	-0.35420617E 06	-0.35420617E 06	0.
4	0	3	-3	0.36341308E 06	0.36341308E 06	0.
4	0	3	-2	0.28476074E 06	0.28476074E 06	0.
4	0	3	1	0.44470161E 05	0.44470161E 05	0.
4	0	3	2	-0.35418769E 06	-0.35418769E 06	0.
4	1	3	-3	0.76206202E 06	0.76206202E 06	0.
4	1	3	-2	0.68340969E 06	0.68340969E 06	0.
4	1	3	1	0.44311911E 06	0.44311911E 06	0.
4	1	3	2	0.44461256E 05	0.44461256E 05	0.
4	2	3	-1	0.68123830E 06	0.68123830E 06	0.
4	2	3	0	0.44312529E 06	0.44312529E 06	0.
4	2	3	3	0.44461272E 05	0.44461272E 05	0.
4	3	3	-1	0.12393646E 07	0.12393646E 07	0.
4	3	3	0	0.10012516E 07	0.10012516E 07	0.
4	3	3	3	0.60258754E 06	0.60258754E 06	C.
4	4	3	-3	0.13201883E 07	0.13201883E 07	0.
4	4	3	-2	0.12415360E 07	0.12415360E 07	0.
4	4	3	1	0.10012454E 07	0.10012454E 07	0.
4	4	3	2	0.60258754E 06	0.60258754E 06	C.
4	-2	4	-4	0.81557390E 05	0.81557390E 05	0.
4	-2	4	-3	0.36189812E 04	0.36189812E 04	0.
4	-1	4	-4	0.31894812E 06	0.31894812E 06	0.
4	-1	4	-3	0.24100971E 06	0.24100971E 06	0.
4	0	4	-2	0.23740921E 06	0.23740921E 06	0.
4	0	4	-1	0.18478601E 02	0.18478601E 02	0.
4	1	4	-2	0.63605816E 06	0.63605816E 06	0.
4	1	4	-1	0.39866743E 06	0.39866743E 06	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
4	2	4	-4	0.71761556E 06	0.71761556E 06	0.
4	2	4	-3	0.63967716E 06	0.63967716E 06	0.
4	2	4	0	0.39864896E 06	0.39864896E 06	0.
4	2	4	1	0.18348093E-01	0.18348093E-01	0.
4	3	4	-4	0.12757418E 07	0.12757418E 07	0.
4	3	4	-3	0.11978034E 07	0.11978034E 07	0.
4	3	4	0	0.95677523E 06	0.95677523E 06	0.
4	3	4	1	0.55812628E 06	0.55812628E 06	0.
4	4	4	-2	0.11941844E 07	0.11941844E 07	0.
4	4	4	-1	0.95679371E 06	0.95679371E 06	0.
4	4	4	2	0.55812627E 06	0.55812627E 06	0.
4	4	4	3	0.46266941E-05	0.46266941E-05	0.
5	-5	4	-4	0.55548865E 05	0.55548865E 05	0.
5	-5	4	-3	-0.22389543E 05	-0.22389543E 05	0.
5	-5	4	0	-0.26341773E 06	-0.26341773E 06	0.
5	-5	4	1	-0.66206668E 06	-0.66206668E 06	0.
5	-5	4	4	-0.12201930E 07	-0.12201930E 07	0.
5	-4	4	-4	0.13260180E 06	0.13260180E 06	0.
5	-4	4	-3	0.54663388E 05	0.54663388E 05	0.
5	-4	4	0	-0.18636480E 06	-0.18636480E 06	0.
5	-4	4	1	-0.58501375E 06	-0.58501375E 06	0.
5	-4	4	4	-0.11431400E 07	-0.11431400E 07	0.
5	-3	4	-2	0.56472833E 05	0.56472833E 05	0.
5	-3	4	-1	-0.18091790E 06	-0.18091790E 06	0.
5	-3	4	2	-0.57958534E 06	-0.57958534E 06	0.
5	-3	4	3	-0.11377116E 07	-0.11377116E 07	0.
5	-2	4	-2	0.29296149E 06	0.29296149E 06	0.
5	-2	4	-1	0.55570763E 05	0.55570763E 05	0.
5	-2	4	2	-0.34309668E 06	-0.34309668E 06	0.
5	-2	4	3	-0.90122295E 06	-0.90122295E 06	0.
5	-1	4	4	0.37456200E 06	0.37456200E 06	0.
5	-1	4	-3	0.29662359E 06	0.29662359E 06	0.
5	-1	4	0	0.55595397E 05	0.55595397E 05	0.
5	-1	4	1	-0.34305355E 06	-0.34305355E 06	0.
5	-1	4	4	-0.90117984E 06	-0.90117984E 06	0.
5	0	4	-4	0.77319325E 06	0.77319325E 06	0.
5	0	4	-3	0.69525484E 06	0.69525484E 06	0.
5	0	4	0	0.45422666E 06	0.45422666E 06	0.
5	0	4	1	0.55577708E 05	0.55577708E 05	0.
5	0	4	4	-0.50254858E 06	-0.50254858E 06	0.
5	1	4	-2	0.69163594E 06	0.69163594E 06	0.
5	1	4	-1	0.45424521E 06	0.45424521E 06	0.
5	1	4	2	0.55577763E 05	0.55577763E 05	0.
5	1	4	3	-0.50254850E 06	-0.50254850E 06	0.
5	2	4	-2	0.12497607E 07	0.12497607E 07	0.
5	2	4	-1	0.10123700E 07	0.10123700E 07	0.
5	2	4	2	0.61370250E 06	0.61370250E 06	0.
5	2	4	3	0.55576238E 05	0.55576238E 05	0.
5	3	4	-4	0.13313181E 07	0.13313181E 07	0.
5	3	4	-3	0.12533797E 07	0.12533797E 07	0.
5	3	4	0	0.10123515E 07	0.10123515E 07	0.
5	3	4	1	0.61370252E 06	0.61370252E 06	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
6	3	4	4	0.55576238E 05	0.55576238E 05	0.
5	4	4	-4	0.20489094E 07	0.20489094E 07	0.
5	4	4	-3	0.19709710E 07	0.19709710E 07	0.
5	4	4	0	0.17299428E 07	0.17299428E 07	0.
5	4	4	1	0.13312938E 07	0.13312938E 07	0.
5	4	4	4	0.77316753E 06	0.77316753E 06	0.
5	4	4	-2	0.19673520E 07	0.19673520E 07	0.
5	5	4	-1	0.17299612E 07	0.17299612E 07	0.
5	5	4	2	0.13312938E 07	0.13312938E 07	0.
5	5	4	3	0.77316753E 06	0.77316753E 06	0.
5	-3	5	-5	0.82481357E 05	0.82481357E 05	0.
5	-3	5	-4	0.54284250E 04	0.54284260E 04	0.
5	-2	5	-5	0.31897002E 06	0.31897002E 06	0.
5	-2	5	-4	0.24191709E 06	0.24191709E 06	0.
5	-1	5	-3	0.23653177E 06	0.23653177E 06	0.
5	-1	5	-2	0.43113654E 02	0.43113654E 02	0.
5	0	5	-3	0.63516303E 06	0.63516303E 06	0.
5	0	5	-2	0.39867437E 06	0.39867437E 06	0.
5	1	5	-5	0.71764446E 06	0.71764446E 06	0.
5	1	5	-4	0.64059153E 06	0.64059153E 06	0.
5	1	5	-1	0.39863133E 06	0.39863133E 06	0.
5	1	5	0	0.73391407E-01	0.73391407E-01	0.
5	2	5	-5	0.12757692E 07	0.12757692E 07	0.
5	2	5	-4	0.11987153E 07	0.11987163E 07	0.
5	2	5	-1	0.95675607E 06	0.95675607E 06	0.
5	2	5	0	0.55812481E 06	0.55812481E 06	0.
5	3	5	-3	0.11932878E 07	0.11932878E 07	0.
5	3	5	-2	0.95579919E 06	0.95679919E 06	0.
5	3	5	1	0.55812474E 06	0.55812474E 06	0.
5	3	5	2	0.41640364E-04	0.41640364E-04	0.
5	4	5	-3	0.19108791E 07	0.19108791E 07	0.
5	4	5	-2	0.16743905E 07	0.16743905E 07	0.
5	4	5	1	0.12757160E 07	0.12757160E 07	0.
5	4	5	2	0.71759129E 06	0.71759129E 06	0.
5	5	5	-5	0.19933605E 07	0.19933605E 07	0.
5	5	5	-4	0.19163076E 07	0.19163076E 07	0.
5	5	5	-1	0.16743474E 07	0.16743474E 07	0.
5	5	5	0	0.12757151E 07	0.12757161E 07	0.
5	5	5	3	0.71759129E 06	0.71759129E 06	0.
5	5	5	4	0.74505806E-08	0.74505806E-08	0.
6	-6	5	-5	0.56645106E 05	0.66645106E 05	0.
6	-6	5	-4	-0.10407824E 05	-0.10407824E 05	0.
6	-6	5	-1	-0.25236802E 06	-0.25236802E 06	0.
6	-6	5	0	-0.65099928E 06	-0.65099928E 06	0.
6	-6	5	3	-0.12091241E 07	-0.12091241E 07	0.
6	-6	5	4	-0.19267154E 07	-0.19267154E 07	0.
6	-5	5	-5	0.14264566E 06	0.14264566E 06	0.
6	-5	5	-4	0.65592729E 05	0.65592729E 05	0.
6	-5	5	-1	-0.17636747E 06	-0.17636747E 06	0.
6	-5	5	0	-0.57499373E 06	-0.57499873E 06	0.
6	-5	5	3	-0.11331235E 07	-0.11331235E 07	0.
6	-5	5	4	-0.18507148E 07	-0.18507148E 07	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
5	-4	5	-3	0.67763980E 05	0.67763980E 05	0.
6	-4	5	-2	-0.16872468E 06	-0.16872469E 06	0.
5	-4	5	1	-0.56739912E 06	-0.56739912E 06	0.
6	-4	5	2	-0.11255239E 07	-0.11255239E 07	0.
6	-4	5	5	-0.18431152E 07	-0.18431152E 07	0.
6	-3	5	-3	0.30317132E 06	0.30317132E 06	0.
6	-3	5	-2	0.66682666E 05	0.66682666E 05	0.
6	-3	5	1	-0.33199178E 06	-0.33199178E 06	0.
6	-3	5	2	-0.89011652E 06	-0.89011652E 06	0.
6	-3	5	5	-0.16077078E 07	-0.16077078E 07	0.
6	-2	5	-5	0.38573830E 06	0.38573890E 06	0.
6	-2	5	-4	0.30868597E 06	0.30869597E 06	0.
6	-2	5	-1	0.66725769E 05	0.66725769E 05	0.
6	-2	5	0	-0.33190549E 06	-0.33190549E 06	0.
6	-2	5	3	-0.89003030E 06	-0.89003030E 06	0.
6	-2	5	4	-0.16076216E 07	-0.16076216E 07	0.
6	-1	5	-5	0.78433930E 06	0.78433930E 06	0.
6	-1	5	-4	0.70728637E 06	0.70728637E 06	0.
6	-1	5	-1	0.46532617E 06	0.46532617E 06	0.
6	-1	5	0	0.66694912E 05	0.66694912E 05	0.
6	-1	5	3	-0.49142990E 06	-0.49142990E 06	0.
6	-1	5	4	-0.12090212E 07	-0.12090212E 07	0.
6	0	5	-3	0.70195816E 06	0.70195816E 06	0.
6	0	5	-2	0.46536950E 06	0.46536950E 06	0.
6	0	5	1	0.66695050E 05	0.66695060E 05	0.
6	0	5	2	-0.49142968E 06	-0.49142969E 06	0.
6	0	5	5	-0.12090210E 07	-0.12090210E 07	0.
6	1	5	-3	0.12599802E 07	0.12599802E 07	0.
6	1	5	-2	0.10234916E 07	0.10234916E 07	0.
6	1	5	1	0.62491714E 06	0.62481714E 06	0.
6	1	5	2	0.66692398E 05	0.66692398E 05	0.
6	1	5	5	-0.65089889E 06	-0.65089889E 06	0.
6	2	5	-5	0.13424616E 07	0.13424616E 07	0.
6	2	5	-4	0.12654087E 07	0.12654087E 07	0.
6	2	5	-1	0.10234485E 07	0.10234485E 07	0.
6	2	5	0	0.62491721E 06	0.62481721E 06	0.
6	2	5	3	0.66692398E 05	0.66692398E 05	0.
6	2	5	4	-0.65089899E 06	-0.65089899E 06	0.
6	3	5	-5	0.20600518E 07	0.20600518E 07	0.
6	3	5	-4	0.19829989E 07	0.19829989E 07	0.
6	3	5	-1	0.17410397E 07	0.17410387E 07	0.
6	3	5	0	0.13424074E 07	0.13424074E 07	0.
6	3	5	3	0.78428258E 06	0.78428258E 06	0.
6	3	5	4	0.66691290E 05	0.66691290E 05	0.
6	4	5	-3	0.19775704E 07	0.19775704E 07	0.
6	4	5		0.17410818E 07	0.17410818E 07	0.
6	4	5		0.13424073E 07	0.13424073E 07	0.
6	4	5		0.78428258E 06	0.78428258E 06	0.
6	4	5	5	0.66691290E 05	0.66691290E 05	0.
6	5	5	-3	0.28546267E 07	0.28546267E 07	0.
6	5	5	-2	0.26181380E 07	0.26181380E 07	0.
6	5	5	1	0.22194636E 07	0.22194636E 07	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
6	5	5	2	0.16613388E 07	0.16613388E 07	0.
6	5	5	5	0.94374755E 06	0.94374755E 06	0.
6	6	5	-5	0.29371080E 07	0.29371080E 07	0.
6	6	5	-4	0.28500551E 07	0.28600551E 07	0.
6	6	5	-1	0.26180949E 07	0.26180949E 07	0.
6	6	5	0	0.22194637E 07	0.22194637E 07	0.
6	6	5	3	0.16613388E 07	0.166133RRE 07	0.
6	6	5	4	0.94374755E 06	0.94374755E 06	0.
6	-4	6	-6	0.83600230E 05	0.83600230E 05	0.
6	-4	6	-5	0.75996790E 04	0.75996790E 04	0.
6	-3	6	-6	0.31900757E 06	0.31900757E 06	0.
6	-3	6	-5	0.24300702E 06	0.24300702E 06	0.
6	-2	6	-4	0.23549356E 06	0.23549356E 06	0.
6	-2	6	-3	0.86216654E 02	0.86216654E 02	0.
6	-1	6	-4	0.63409396E 06	0.63409396E 06	0.
6	-1	6	-3	0.39868662E 06	0.39868662E 06	0.
6	0	6	-6	0.71769441E 06	0.71769441E 06	0.
6	0	6	-5	0.64169386E 06	0.64169386E 06	0.
6	0	6	-2	0.39860062E 06	0.39860062E 06	0.
6	0	6	-1	0.22016944E-00	0.22016944E-00	0.
6	1	6	-6	0.12758165E 07	0.12758165E 07	0.
6	1	6	-5	0.11998159E 07	0.11998159E 07	0.
6	1	6	-2	0.95672270E 06	0.95672270E 06	0.
6	1	6	-1	0.55812230E 06	0.55812230E 06	0.
6	2	6	-4	0.11922163E 07	0.11922163E 07	0.
6	2	6	-3	0.95680892E 06	0.95680892E 06	0.
6	2	6	0	0.55812208E 06	0.55812208E 06	0.
6	2	6	1	0.20820077E-03	0.20820077E-03	0.
6	3	6	-4	0.19098065E 07	0.19098065E 07	0.
6	3	6	-3	0.16743991E 07	0.16743991E 07	0.
6	3	6	0	0.12757123E 07	0.12757123E 07	0.
6	3	6	1	0.71759018E 06	0.71759018E 06	0.
6	4	6	-6	0.19934057E 07	0.19934067E 07	0.
6	4	6	-5	0.19174061E 07	0.19174061E 07	0.
6	4	6	-2	0.16743129E 07	0.16743129E 07	0.
6	4	6	-1	0.12757125E 07	0.12757125E 07	0.
6	4	6	2	0.71759018E 06	0.71759018E 06	0.
6	4	6	3	0.81025064E-07	0.81025064E-07	0.
6	5	6	-6	0.28704629E 07	0.28704629E 07	0.
6	5	6	-5	0.27944624E 07	0.27944624E 07	0.
6	5	6	-2	0.25513692E 07	0.25513692E 07	0.
6	5	6	-1	0.21527687E 07	0.21527687E 07	0.
6	5	6	2	0.15946464E 07	0.15946464E 07	0.
6	5	6	3	0.87705626E 06	0.87705626E 06	0.
6	5	6	-4	0.27869627E 07	0.27869627E 07	0.
6	6	6	-3	0.25514553E 07	0.25514553E 07	0.
6	6	6	0	0.21527685E 07	0.21527685E 07	0.
6	6	6	1	0.15946464E 07	0.15946464E 07	0.
6	6	6	4	0.87705626E 06	0.87705626E 06	0.
6	6	6	5	0.23283064E-09	0.23283064E-09	0.
7	-7	6	-6	0.77733947E 05	0.77733947E 05	0.
7	-7	6	-5	0.17333955E 04	0.17333955E 04	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
7	-7	6	-2	-0.24135995E 06	-0.24135985E 06	0.
7	-7	6	-1	-0.63996024E 06	-0.63996024E 06	0.
7	-7	6	2	-0.11980825E 07	-0.11980825E 07	0.
7	-7	6	3	-0.19156727E 07	-0.19156727E 07	0.
7	-7	6	6	-0.27927290E 07	-0.27927290E 07	0.
7	-6	6	-6	0.15252079E 06	0.15252079E 06	0.
7	-6	6	-5	0.76520235E 05	0.76520235E 05	0.
7	-6	6	-2	-0.16657300E 06	-0.16657300E 06	0.
7	-6	6	-1	-0.56517341E 06	-0.56517341E 06	0.
7	-6	6	2	-0.11232957E 07	-0.11232957E 07	0.
7	-6	6	3	-0.18408859E 07	-0.18408859E 07	0.
7	-6	6	6	-0.27179422E 07	-0.27179422E 07	0.
7	-5	6	-4	0.79053205E 05	0.79053205E 05	0.
7	-5	6	-3	-0.15635414E 06	-0.15635414E 06	0.
7	-5	6	0	-0.55504098E 06	-0.55504098E 06	0.
7	-5	6	1	-0.11131631E 07	-0.11131631E 07	0.
7	-5	6	4	-0.18307532E 07	-0.18307532E 07	0.
7	-5	6	5	-0.27078095E 07	-0.27078095E 07	0.
7	-4	6	-4	0.31320065E 06	0.31320065E 06	0.
7	-4	6	-3	0.77793309E 05	0.77793309E 05	0.
7	-4	6	0	-0.32089353E 06	-0.32089353E 06	0.
7	-4	6	1	-0.87901561E 06	-0.87901561E 06	0.
7	-4	6	4	-0.15966058E 07	-0.15966058E 07	0.
7	-4	6	5	-0.24736621E 07	-0.24736621E 07	0.
7	-3	6	-6	0.39695604E 06	0.39695604E 06	0.
7	-3	6	-5	0.32095549E 06	0.32095549E 06	0.
7	-3	6	-2	0.77862252E 05	0.77862252E 05	0.
7	-3	6	-1	-0.32073815E 06	-0.32073815E 06	0.
7	-3	6	2	-0.87886045E 06	-0.87886045E 06	0.
7	-3	6	3	-0.15964506E 07	-0.15964506E 07	0.
7	-3	6	6	-0.24735069E 07	-0.24735069E 07	0.
7	-2	6	-6	0.79550717E 06	0.79550717E 06	0.
7	-2	6	-5	0.71950662E 06	0.71950662E 06	0.
7	-2	6	-2	0.47641338E 06	0.47641338E 06	0.
7	-2	6	-1	0.77812977E 05	0.77812977E 05	0.
7	-2	6	2	-0.48030932E 06	-0.48030932E 06	0.
7	-2	6	3	-0.11979995E 07	-0.11979995E 07	0.
7	-2	6	6	-0.20749558E 07	-0.20749558E 07	0.
7	-1	6	-4	0.71190749E 06	0.71190749E 06	0.
7	-1	6	-3	0.47650014E 06	0.47650014E 06	0.
7	-1	6	0	0.77813307E 05	0.77813307E 05	0.
7	-1	6	1	-0.48030877E 06	-0.48030877E 06	0.
7	-1	6	4	-0.11978990E 07	-0.11978990E 07	0.
7	-1	6	5	-0.20749552E 07	-0.20749552E 07	0.
7	0	6	-4	0.12700253E 07	0.12700253E 07	0.
7	0	6	-3	0.10346179E 07	0.10346179E 07	0.
7	0	6	0	0.63593110E 06	0.63593110E 06	0.
7	0	6	1	0.77809023E 05	0.77809023E 05	0.
7	0	6	4	-0.63978116E 06	-0.63978116E 06	0.
7	0	6	5	-0.15168374E 07	-0.15168374E 07	0.
7	1	6	-6	0.13536255E 07	0.13536255E 07	0.
7	1	6	-5	0.12776250E 07	0.12776250E 07	0.

76

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
7	1	6	-2	0.10345317E 07	0.10345317E 07	0.
7	1	6	-1	0.63593133E 06	0.63593133E 06	0.
7	1	6	2	0.77809023E 05	0.77809023E 05	0.
7	1	6	3	-0.63978116E 06	-0.63978116E 06	0.
7	1	6	6	-0.15168374E 07	-0.15168374E 07	0.
7	2	6	-6	0.20712139E 07	0.20712139E 07	0.
7	2	6	-5	0.19952134E 07	0.19952134E 07	0.
7	2	6	-2	0.17521201E 07	0.17521201E 07	0.
7	2	6	-1	0.13535197E 07	0.13535197E 07	0.
7	2	6	2	0.79539745E 06	0.79539745E 06	0.
7	2	6	3	0.77807263E 05	0.77807263E 05	0.
7	2	6	6	-0.79924900E 06	-0.79924900E 06	0.
7	3	6	-4	0.19876137E 07	0.19876137E 07	0.
7	3	6	-3	0.17522064E 07	0.17522064E 07	0.
7	3	6	0	0.13535195E 07	0.13535195E 07	0.
7	3	6	1	0.79539745E 06	0.79539745E 06	0.
7	3	6	4	0.77807263E 05	0.77807263E 05	0.
7	3	6	5	-0.79924900E 06	-0.79924900E 06	0.
7	4	6	-4	0.29646690E 07	0.28646690E 07	0.
7	4	6	-3	0.26292617E 07	0.26292617E 07	0.
7	4	6	0	0.22305749E 07	0.22305749E 07	0.
7	4	6	1	0.16724528E 07	0.16724528E 07	0.
7	4	5	4	0.95486260E 06	0.95486260E 06	0.
7	4	6	5	0.77806340E 05	0.77806340E 05	0.
7	5	5	-6	0.29482693E 07	0.29482693E 07	0.
7	5	6	-5	0.28722697E 07	0.28722687E 07	0.
7	5	6	-2	0.26291755E 07	0.26291755E 07	0.
7	5	6	-1	0.22305751E 07	0.22305751E 07	0.
7	5	6	2	0.16724528E 07	0.16724528E 07	0.
7	5	6	3	0.95486260E 06	0.95486260E 06	0.
7	5	5	6	0.77806340E 05	0.77806340E 05	0.
7	6	6	-6	0.39847905E 07	0.39847905E 07	0.
7	6	6	-5	0.39087899E 07	0.39087899E 07	0.
7	6	6	-2	0.36656967E 07	0.36656967E 07	0.
7	6	6	-1	0.32670963E 07	0.32670963E 07	0.
7	6	6	2	0.27089740E 07	0.27089740E 07	0.
7	6	6	3	0.19913838E 07	0.19913838E 07	0.
7	6	6	6	0.11143275E 07	0.11143275E 07	0.
7	7	6	-4	0.39011902E 07	0.39011902E 07	0.
7	7	6	-3	0.36657829E 07	0.36657829E 07	0.
7	7	6	0	0.32670961E 07	0.32670961E 07	0.
7	7	6	1	0.27089740E 07	0.27089740E 07	0.
7	7	6	4	0.19913838E 07	0.19913838E 07	0.
7	7	6	5	0.11143275E 07	0.11143275E 07	0.
7	-5	7	-7	0.84919489E 05	0.84919489E 05	0.
7	-5	7	-6	0.10132648E 05	0.10132648E 05	0.
7	-4	7	-7	0.31906694E 06	0.31906694E 06	0.
7	-4	7	-6	0.24428010E 06	0.24428010E 06	0.
7	-3	7	-5	0.23430261E 06	0.23430261E 06	0.
7	-3	7	-4	0.15515955E 03	0.15515955E 03	0.
7	-2	7	-5	0.63285373E 06	0.63285373E 06	0.
7	-2	7	-4	0.39870629E 06	0.39870629E 06	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
7	-1	7	-7	0.71777377E 06	0.71777377E 06	0.
7	-1	7	-6	0.64298693E 06	0.64298693E 06	0.
7	-1	7	-3	0.39855168E 06	0.39855168E 06	0.
7	-1	7	-2	0.55040459E 00	0.55040459E 00	0.
7	0	7	-7	0.12758916E 07	0.12758916E 07	0.
7	0	7	-6	0.12011047E 07	0.12011047E 07	0.
7	0	7	-3	0.95666948E 06	0.95666948E 06	0.
7	0	7	-2	0.55811834E 06	0.55811834E 06	0.
7	1	7	-5	0.11909721E 07	0.11909721E 07	0.
7	1	7	-4	0.95682463E 06	0.95682463E 06	0.
7	1	7	-1	0.55811780E 06	0.55811780E 06	0.
7	1	7	0	0.76339231E-03	0.76339231E-03	0.
7	2	7	-5	0.19085605E 07	0.19085605E 07	0.
7	2	7	-4	0.16744131E 07	0.16744131E 07	0.
7	2	7	-1	0.12757062E 07	0.12757062E 07	0.
7	2	7	0	0.71758842E 06	0.71758842E 06	0.
7	3	7	-7	0.19934800E 07	0.19934800E 07	0.
7	3	7	-6	0.19186932E 07	0.19186932E 07	0.
7	3	7	-3	0.16742579E 07	0.16742579E 07	0.
7	3	7	-2	0.12757068E 07	0.12757068E 07	0.
7	3	7	1	0.71758842E 06	0.71758842E 06	0.
7	3	7	2	0.48731454E-06	0.48731454E-06	0.
7	4	7	-7	0.28705353E 07	0.28705353E 07	0.
7	4	7	-6	0.27957485E 07	0.27957485E 07	0.
7	4	7	-3	0.25513132E 07	0.25513132E 07	0.
7	4	7	-2	0.21527621E 07	0.21527621E 07	0.
7	4	7	1	0.15946438E 07	0.15946438E 07	0.
7	4	7	2	0.87705534E 06	0.87705534E 06	0.
7	5	7	-5	0.27856158E 07	0.27856158E 07	0.
7	5	7	-4	0.25514684E 07	0.25514684E 07	0.
7	5	7	-1	0.21527616E 07	0.21527616E 07	0.
7	5	7	0	0.15946438E 07	0.15946438E 07	0.
7	5	7	3	0.87705534E 06	0.37705534E 06	0.
7	5	7	4	0.23283064E-09	0.23283064E-09	0.
7	6	7	-5	0.38221370E 07	0.38221370E 07	0.
7	6	7	-4	0.35879896E 07	0.35879896E 07	0.
7	6	7	-1	0.31892827E 07	0.31892827E 07	0.
7	6	7	0	0.26311650E 07	0.26311650E 07	0.
7	6	7	3	0.19135765E 07	0.19135765E 07	0.
7	6	7	4	0.10365212E 07	0.10365212E 07	0.
7	7	7	-7	0.39070565E 07	0.39070565E 07	0.
7	7	7	-6	0.38322697E 07	0.38322697E 07	0.
7	7	7	-3	0.35878344E 07	0.35878344E 07	0.
7	7	7	-2	0.31892833E 07	0.31892833E 07	0.
7	7	7	1	0.26311650E 07	0.26311650E 07	0.
7	7	7	2	0.19135765E 07	0.19135765E 07	0.
7	7	7	5	0.10365212E 07	0.10365212E 07	0.
7	7	7	6	0.	0.	0.
8	-8	7	-7	0.88814234E 05	0.88814234E 05	0.
8	-8	7	-6	0.14027394E 05	0.14027394E 05	0.
8	-8	7	-3	-0.23040786E 06	-0.23040786E 06	0.
8	-8	7	-2	-0.62895898E 06	-0.62895898E 06	0.

78

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
4	-4	7	1	-0.11870773E 07	-0.11870773E 07	0.
4	-9	7	2	-0.19046658E 07	-0.19046658E 07	0.
4	-8	7	5	-0.27817211E 07	-0.27817211E 07	0.
8	-8	7	6	-0.38182423E 07	-0.38182423E 07	0.
8	-7	7	-7	0.16223255E 06	0.16223255E 06	0.
9	-7	7	-6	0.87445709E 05	0.87445709E 05	0.
8	-7	7	-3	-0.15698955E 06	-0.15698955E 06	0.
8	-7	7	-2	-0.55554067E 06	-0.55554067E 06	0.
8	-7	7	1	-0.11136590E 07	-0.11136590E 07	0.
9	-7	7	2	-0.18312474E 07	-0.18312474E 07	0.
9	-7	7	5	-0.27083028E 07	-0.27083028E 07	0.
8	-7	7	6	-0.37448240E 07	-0.37448240E 07	0.
9	-6	7	-5	0.90340248E 05	0.90340248E 05	0.
9	-6	7	-4	-0.14380720E 06	-0.14380720E 06	0.
8	-6	7	-1	-0.54251403E 06	-0.54251403E 06	0.
8	-6	7	0	-0.11006318E 07	-0.11006318E 07	0.
6	-6	7	3	-0.18182202E 07	-0.18182202E 07	0.
8	-6	7	4	-0.26952756E 07	-0.26952756E 07	0.
4	-6	7	7	-0.37317968E 07	-0.37317968E 07	0.
8	-5	7	-5	0.32304999E 06	0.32304999E 06	0.
8	-5	7	-4	0.88902544E 05	0.88902544E 05	0.
8	-5	7	-1	-0.30980429E 06	-0.30980429E 06	0.
9	-5	7	0	-0.86792209E 06	-0.86792209E 06	0.
8	-5	7	3	-0.15855105E 07	-0.15855105E 07	0.
9	-5	7	4	-0.24625658E 07	-0.24625658E 07	0.
8	-5	7	7	-0.34990871E 07	-0.34990871E 07	0.
8	-4	7	-7	0.40822800E 06	0.40822800E 06	0.
8	-4	7	-6	0.33344116E 06	0.33344116E 06	0.
9	-4	7	-3	0.89005907E 05	0.89005907E 05	0.
8	-4	7	-2	-0.30954522E 06	-0.30954522E 06	0.
8	-4	7	1	-0.86766357E 06	-0.86766357E 06	0.
8	-4	7	2	-0.15852520E 07	-0.15852520E 07	0.
8	-4	7	5	-0.24623073E 07	-0.24623073E 07	0.
9	-4	7	6	-0.34988285E 07	-0.34988285E 07	0.
8	-3	7	-7	0.80670527E 06	0.80670527E 06	0.
8	-3	7	-6	0.73191844E 06	0.73191844E 06	0.
8	-3	7	-3	0.48748318E 06	0.48748318E 06	0.
8	-3	7	-2	0.88932055E 05	0.88932055E 05	0.
8	-3	7	1	-0.46918629E 06	-0.46918529E 06	0.
8	-3	7	2	-0.11867747E 07	-0.11867747E 07	0.
8	-3	7	5	-0.20638301E 07	-0.20638301E 07	0.
8	-3	7	6	-0.31003512E 07	-0.31003512E 07	0.
8	-2	7	-5	0.72178700E 06	0.72178700E 06	0.
8	-2	7	-4	0.48763955E 06	0.48763955E 06	0.
8	-2	7	-1	0.88932716E 05	0.88932716E 05	0.
8	-2	7	0	-0.46918508E 06	-0.46918508E 06	0.
8	-2	7	3	-0.11867735E 07	-0.11867735E 07	0.
8	-2	7	4	-0.20638288E 07	-0.20638288E 07	0.
8	-2	7	7	-0.31003500E 07	-0.31003500E 07	0.
8	-1	7	-5	0.12798983E 07	0.12798983E 07	0.
8	-1	7	-4	0.10457509E 07	0.10457509E 07	0.
8	-1	7	-1	0.64704405E 06	0.64704405E 06	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
8	-1	7	0	0.88926251E 05	0.88926251E 05	0.
8	-1	7	3	-0.62866217E 06	-0.62866217E 06	0.
8	-1	7	4	-0.15057175E 07	-0.15057175E 07	0.
8	-1	7	7	-0.25422387E 07	-0.25422387E 07	0.
8	0	7	-7	0.13648178E 07	0.13648178E 07	0.
8	0	7	-6	0.12900310E 07	0.12900310E 07	0.
8	0	7	-3	0.10455957E 07	0.10455957E 07	0.
8	0	7	-2	0.64704460E 06	0.64704460E 06	0.
8	0	7	1	0.88926253E 05	0.88926253E 05	0.
8	0	7	2	-0.62866216E 06	-0.62866216E 06	0.
8	0	7	5	-0.15057175E 07	-0.15057175E 07	0.
8	0	7	6	-0.25422387E 07	-0.25422387E 07	0.
8	1	7	-7	0.20824036E 07	0.20824036E 07	0.
8	1	7	-6	0.20076168E 07	0.20076168E 07	0.
8	1	7	-3	0.17631815E 07	0.17631815E 07	0.
8	1	7	-2	0.13646304E 07	0.13646304E 07	0.
8	1	7	1	0.80651205E 06	0.80651205E 06	0.
8	1	7	2	0.88923623E 05	0.88923623E 05	0.
8	1	7	5	-0.78813171E 06	-0.78813171E 06	0.
8	1	7	6	-0.18246529E 07	-0.18246529E 07	0.
8	2	7	-5	0.19974841E 07	0.19974841E 07	0.
8	2	7	-4	0.17633367E 07	0.17633367E 07	0.
8	2	7	-1	0.13646298E 07	0.13646298E 07	0.
8	2	7	0	0.80651205E 06	0.80651205E 06	0.
8	2	7	3	0.88923623E 05	0.88923623E 05	0.
8	2	7	4	-0.78813171E 06	-0.78813171E 06	0.
8	2	7	7	-0.18246529E 07	-0.18246529E 07	0.
8	3	7	-5	0.28745381E 07	0.28745381E 07	0.
8	3	7	-4	0.26403906E 07	0.26403906E 07	0.
8	3	7	-1	0.22416838E 07	0.22416838E 07	0.
8	3	7	0	0.16835660E 07	0.16835660E 07	0.
8	3	7	3	0.96597759E 06	0.96597759E 06	0.
8	3	7	4	0.88922247E 05	0.88922247E 05	0.
8	3	7	7	-0.94759895E 06	-0.94759895E 06	0.
8	4	7	-7	0.29594576E 07	0.29594576E 07	0.
8	4	7	-6	0.28846707E 07	0.28846707E 07	0.
8	4	7	-3	0.26402355E 07	0.26402355E 07	0.
8	4	7	-2	0.22416843E 07	0.22416843E 07	0.
8	4	7	1	0.16835660E 07	0.16835660E 07	0.
8	4	7	2	0.96597759E 06	0.96597759E 06	0.
8	4	7	5	0.88922247E 05	0.88922247E 05	0.
8	4	7	6	-0.94759895E 06	-0.94759895E 06	0.
8	5	7	-7	0.39959780E 07	0.39959780E 07	0.
8	5	7	-6	0.39211911E 07	0.39211911E 07	0.
8	5	7	-3	0.36767559E 07	0.36767559E 07	0.
8	5	7	-2	0.32782047E 07	0.32782047E 07	0.
8	5	7	1	0.27200864E 07	0.27200864E 07	0.
8	5	7	2	0.20024980E 07	0.20024980E 07	0.
8	5	7	5	0.11254426E 07	0.11254426E 07	0.
8	5	7	6	0.88921434E 05	0.88921434E 05	0.
8	6	7	-5	0.39110585E 07	0.39110585E 07	0.
8	6	7	-4	0.36769110E 07	0.36769110E 07	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
8	6	7	-1	0.32782042E 07	0.32782042E 07	0.
8	6	7	0	0.27200864E 07	0.27200864E 07	0.
8	6	7	3	0.20024980E 07	0.20024980E 07	0.
8	6	7	4	0.11254426E 07	0.11254426E 07	0.
8	6	7	7	0.88921434E 05	0.88921434E 05	0.
8	7	7	-5	0.51070446E 07	0.51070446E 07	0.
8	7	7	-4	0.48728971E 07	0.48728971E 07	0.
8	7	7	-1	0.44741903E 07	0.44741903E 07	0.
8	7	7	0	0.39160725E 07	0.39160725E 07	0.
8	7	7	3	0.31984841E 07	0.31984841E 07	0.
8	7	7	4	0.23214287E 07	0.23214287E 07	0.
8	7	7	7	0.12849076E 07	0.12849076E 07	0.
8	8	7	-7	0.51919641E 07	0.51919641E 07	0.
8	8	7	-6	0.51171772E 07	0.51171772E 07	0.
8	8	7	-3	0.48727420E 07	0.48727420E 07	0.
8	8	7	-2	0.44741909E 07	0.44741909E 07	0.
8	8	7	1	0.39160725E 07	0.39160725E 07	0.
8	8	7	2	0.31984841E 07	0.31984841E 07	0.
8	8	7	5	0.23214287E 07	0.23214287E 07	0.
8	8	7	6	0.12849076E 07	0.12849076E 07	0.
8	-6	8	-8	0.86445502E 05	0.86445502E 05	0.
8	-6	8	-7	0.13027188E 05	0.13027188E 05	0.
8	-5	8	-8	0.31915525E 06	0.31915525E 06	0.
8	-5	8	-7	0.24573693E 06	0.24573693E 06	0.
8	-4	8	-6	0.23296827E 06	0.23296827E 06	0.
8	-4	8	-5	0.25852362E 03	0.25852362E 03	0.
8	-3	8	-6	0.63144554E 06	0.63144554E 06	0.
8	-3	8	-5	0.39873580E 06	0.39873580E 06	0.
8	-2	8	-8	0.71789225E 06	0.71789225E 06	0.
8	-2	8	-7	0.64447394E 06	0.64447394E 06	0.
8	-2	8	-4	0.39847848E 06	0.39847848E 06	0.
8	-2	8	-3	0.12108278E 01	0.12108278E 01	0.
8	-1	8	-8	0.12760036E 07	0.12760036E 07	0.
8	-1	8	-7	0.12025853E 07	0.12025853E 07	0.
8	-1	8	-4	0.95658982E 06	0.95658982E 06	0.
8	-1	8	-3	0.55811254E 06	0.55811254E 06	0.
8	0	8	-6	0.11895581E 07	0.11895581E 07	0.
8	0	8	-5	0.95684834E 06	0.95684834E 06	0.
8	0	8	-2	0.55811134E 06	0.55811134E 06	0.
8	0	8	-1	0.22901366E-02	0.22901366E-02	0.
8	1	8	-6	0.19071439E 07	0.19071439E 07	0.
8	1	8	-5	0.16744341E 07	0.16744341E 07	0.
8	1	8	-2	0.12756971E 07	0.12756971E 07	0.
8	1	8	-1	0.71758580E 06	0.71758580E 06	0.
8	2	8	-8	0.19935894E 07	0.19935894E 07	0.
8	2	8	-7	0.19201711E 07	0.19201711E 07	0.
8	2	8	-4	0.16741756E 07	0.16741756E 07	0.
8	2	8	-3	0.12756983E 07	0.12756983E 07	0.
8	2	8	0	0.71758579E 06	0.71758579E 06	0.
8	2	8	1	0.21115411E-05	0.21115411E-05	0.
8	3	8	-8	0.28706433E 07	0.28706433E 07	0.
8	3	8	-7	0.27972250E 07	0.27972250E 07	0.

J 1	TAU 1	J 2	TAU 2	RIGID ROTOR	NU CALCULATED	NU INPUT
8	3	8	-4	0.25512296E 07	0.25512296E 07	0.
9	3	8	-3	0.21527523E 07	0.21527523E 07	0.
8	3	8	0	0.15946397E 07	0.15946397E 07	0.
9	3	8	1	0.87705396E 06	0.87705396E 06	0.
9	4	8	-6	0.27841978E 07	0.27841978E 07	0.
9	4	8	-5	0.25514881E 07	0.25514981E 07	0.
8	4	9	-2	0.21527511E 07	0.21527511E 07	0.
8	4	8	-1	0.15946397E 07	0.15946397E 07	0.
9	4	8	2	0.87705396E 06	0.87705396E 06	0.
8	4	8	3	0.93132257E-09	0.93132257E-09	0.
9	5	8	-6	0.38207182E 07	0.38207182E 07	0.
8	5	8	-5	0.35880085E 07	0.35880085E 07	0.
9	5	8	-2	0.31892715E 07	0.31892715E 07	0.
8	5	9	-1	0.26311602E 07	0.26311602E 07	0.
8	5	8	2	0.19135743E 07	0.19135743E 07	0.
9	5	8	3	0.10365204E 07	0.10365204E 07	0.
9	6	8	-8	0.39071637E 07	0.39071637E 07	0.
9	6	8	-7	0.38337454E 07	0.38337454E 07	0.
8	6	8	-4	0.35877500E 07	0.35877500E 07	0.
8	6	8	-3	0.31892727E 07	0.31892727E 07	0.
8	6	8	0	0.26311601E 07	0.26311601E 07	0.
9	6	8	1	0.19135743E 07	0.19135743E 07	0.
8	6	8	4	0.10365204E 07	0.10365204E 07	0.
9	6	8	5	0.	0.	0.
8	7	8	-8	0.51031499E 07	0.51031499E 07	0.
8	7	8	-7	0.50297316E 07	0.50297316E 07	0.
8	7	8	-4	0.47837361E 07	0.47837361E 07	0.
8	7	8	-3	0.43852588E 07	0.43852588E 07	0.
9	7	8	0	0.38271463E 07	0.38271463E 07	0.
9	7	8	1	0.31095605E 07	0.31095605E 07	0.
9	7	8	4	0.22325065E 07	0.22325065E 07	0.
8	7	8	5	0.11959861E 07	0.11959861E 07	0.
8	8	8	-6	0.50167044E 07	0.50167044E 07	0.
8	8	8	-5	0.47839946E 07	0.47839946E 07	0.
8	8	8	-2	0.43852576E 07	0.43852576E 07	0.
8	8	8	-1	0.38271463E 07	0.38271463E 07	0.
8	8	8	2	0.31095405E 07	0.31095605E 07	0.
8	8	8	3	0.22325065E 07	0.22325065E 07	0.
8	8	8	6	0.11959861E 07	0.11959861E 07	0.
8	8	8	7	0.	-0.	0.

APPENDIX B

CALCULATION OF THE TIME DEPENDENCE OF
THE EXPECTATION VALUE OF THE POLARIZATION OPERATOR

One of the best elementary methods of determining the frequencies which will arise in a nonlinear medium as a result of an input of frequency ω is to compute the expected value of the polarization operator for the perturbed state (here assumed to be the ground state), i.e. $< \psi \mid er \mid \psi >$. More specifically, the time dependence of this expectation value is desired. These terms have been computed through second order (yielding second harmonic terms) in Reference 40, but the third order terms from which the third harmonics must be determined are not found in the literature. The electric dipole approximation is used; this should be especially good at millimeter wavelengths, since the wavelength is very much larger than the molecular or atomic dimensions. In order to establish the notation, the time dependent perturbation theory of Reference 41 is briefly reviewed.

Let H = Hamiltonian (independent of time)

S = S(t) = time dependent perturbation

Then the Schrödinger equation is

$$(H + S) \ \Psi = i\hbar \ \frac{\partial \Psi}{\partial t}$$

Determine a complete orthonormal set by the eigenfunctions of the unperturbed operator:

$$H\phi_{n} = E_n \ \phi_n .$$

Express the state function ψ as a series, with time dependent coefficients, of the ϕ_n :

$$\Psi(x,t) = \sum_{n} a_n(t) e^{- iE_n t/\hbar} \ \phi_n .$$

Then substituting in the Schrödinger equation, taking the scalar product, from the left, by ϕ_K, and employing orthonormality, we obtain

$$i\hbar \frac{da_k}{dt} = \sum_n S_{kn}\, a_n$$

where

$$S_{kn} = e^{i(\varepsilon_k - \varepsilon_n)t/\hbar} < \phi_k |S| \phi_n > = e^{i\omega_{kn}t} < k|S|n >;$$

with an obvious change of notation $\omega_{kn} = (E_k - E_n)/h$. When S is a function of t, a method of successive approximations is necessary. Although Frenkel regards the quantities S_{kn} as small of the first order, it appears by the Picard-Lindelöf theorem that continuity of S on an interval, satisfying a uniform Lipschitz condition, is sufficient to ensure uniform convergence. For details of the proof (a constructive one) see Reference 42, Chap. II and Exercise 1.1 of Chap. IV.

We let

$$a_k(t) = a_k^{(0)} + a_k^{(1)}(t) + a_k^{(2)}(t) + a_k^{(3)}(t) + \ldots\ldots$$

Then

$$i\hbar \frac{d}{dt} a_k^{(1)} = \sum_n S_{kn}\, a_n^{(0)}$$

$$i\hbar \frac{d}{dt} a_j^{(2)} = \sum_m S_{jm}\, a_m^{(1)}$$

$$i\hbar \frac{d}{dt} a_i^{(3)} = \sum_p S_{ip}\, a_p^{(2)}$$

where $a_k^{(0)}$ is the initial value of $a_k(t)$.

Since the S_{kn} are known functions of time, we may integrate these equations, obtaining:

$$a_k^{(1)} = -\frac{i}{\hbar} \sum_n a_n^{(o)} \int_o^t S_{kn}(t') \, dt'$$

$$a_k^{(2)} = -\frac{1}{\hbar^2} \sum_m \sum_n a_n^{(o)} \int_o^t S_{km}(t') \int_o^{t'} S_{mn}(t'') \, dt'' \, dt'$$

$$a_k^{(3)} = +\frac{i}{\hbar^3} \sum_p \sum_m \sum_n a_n^{(o)} \int_o^t S_{kp}(t') \int_o^{t'} S_{pm}(t'') \int_o^{t''} S_{mn}(t''') \, dt''' \, dt'' \, dt'$$

These equations are for an arbitrary initial superposition of states. If we know that the initial state is the gth state we may let $a_n^{(0)} = \delta_{ng} a_g^{(0)}$, and we have:

$$a_k^{(1)} = -\frac{i}{\hbar} a_g^{(o)} \int_o^t S_{kn}(t') \, dt'$$

$$a_k^{(2)} = -\frac{1}{\hbar^2} \sum_m a_g^{(o)} \int_o^t S_{km}(t') \int_o^{t'} S_{mg}(t'') \, dt'' \, dt'$$

$$a_k^{(3)} = \frac{i}{\hbar^3} \sum_p \sum_m a_g^{(o)} \int_o^t S_{kp}(t') \int_o^{t'} S_{pm}(t'') \int_o^{t''} S_{mg}(t''') \, dt''' \, dt'' \, dt'.$$

Since the algebra for these states becomes very unwieldy, it is not desirable to go beyond the third order.

If we assume that the system is in state g before the perturbation is applied, the wave function is $\psi = \phi_g \exp(i\omega_g t)$. After application of the perturbation the state function is:

$$\Psi = \sum_n (\delta_{ng} + a_n^{(1)} + a_n^{(2)} + a_n^{(3)}) \phi_n e^{-i\omega_n t}.$$

Radiation from the system will be dependent on the expectation value of the polarization operator for the perturbed state $\langle\psi| er| \psi\rangle$. To calculate this expectation value we first need to determine the time dependent coefficient a_k.

We assume the electric field is of the form

$$\underline{\varepsilon} = \underline{\varepsilon}_0 \sin \omega t = E_0 \frac{e^{i\omega t} - e^{-i\omega t}}{2i}.$$

The perturbation Hamiltonian is, in the dipole approximation, $S = e\, E \cdot r$. The matrix elements are then

$$S_{kn} = e^{i\omega_{kn}t} < \phi_k | e\underline{\varepsilon}_0 \cdot \underline{r} \, \frac{e^{i\omega t} - e^{-i\omega t}}{2i} | \phi_n >$$

$$= \frac{e^{i(\omega+\omega_{kn})t} - e^{-i(\omega-\omega_{kn})t}}{2i} < k | e\underline{\varepsilon}_0 \cdot \underline{r} | n >.$$

Substituting in the expression for the time dependent coefficients:

$$a_n^{(1)}(t) = - \frac{e}{2i\hbar} < n | \underline{\varepsilon}_0 \cdot \underline{r} | g > \left[\frac{e^{i(\omega_{ng}+\omega)t} - 1}{(\omega_{ng}+\omega)} - \frac{e^{i(\omega_{ng}-\omega)t} - 1}{(\omega_{ng}-\omega)} \right]$$

$$a_n^{(2)}(t) = \frac{e^2}{4\hbar^2} \sum_m < \varepsilon_0 \cdot r >_{nm} < E_0 \cdot r >_{mg} \left\{ \frac{1}{\omega_{mg} + \omega} \right.$$

$$\times \left[\frac{e^{i(\omega_{ng}+2\omega)t} - 1}{(\omega_{ng} + 2\omega)} + \frac{e^{i(\omega_{nm}-\omega)t} - 1}{(\omega_{nm} - \omega)} - \frac{e^{i\omega_{ng}t} - 1}{\omega_{ng}} - \frac{e^{i(\omega_{nm}+\omega)t} - 1}{(\omega_{nm} + \omega)} \right]$$

$$- \frac{1}{\omega_{mg} - \omega} \left[\frac{e^{i\omega_{ng}t} - 1}{\omega_{ng}} - \frac{e^{i(\omega_{ng}-2\omega)t} - 1}{(\omega_{ng} - 2\omega)} - \frac{e^{i(\omega_{nm}+\omega)t} - 1}{(\omega_{nm} + \omega)} \right.$$

$$\left. \left. + \frac{e^{i(\omega_{nm}-\omega)t} - 1}{(\omega_{nm} - \omega)} \right] \right\}$$

$$a_n^{(3)} = - \frac{i}{\hbar^3} \sum_{j} \sum_{m} a_g^0 \int_0^t S_{nj}(t')dt' \int_0^{t'} S_{jn}(t'')dt'' \int_0^{t''} S_{mg}(t''')dt''' \quad \text{where}$$

$$\psi_n(t) = <\phi_n|e\underline{\varepsilon}_o\cdot\underline{r}|\phi_g> e^{i\omega_{ng}t}\frac{e^{i\omega t} - e^{-i\omega t}}{2i} + (\ldots)$$

$$= + \frac{1}{\hbar^3}\sum_{jm}<\phi_n|e\underline{\varepsilon}_o\cdot\underline{r}|\phi_j><\phi_j|e\underline{\varepsilon}_o\cdot\underline{r}|\phi_m><\phi_n|e\underline{\varepsilon}_o\cdot\underline{r}|\phi_j>$$

$$\left[-\frac{e^{i(\omega_{ng}+3\omega)t}-1}{(\omega_{mg}+\omega)(\omega_{jg}+2\omega)(\omega_{ng}+3\omega)} + \frac{e^{i(\omega_{nj}+\omega)t}-1}{(\omega_{mg}+\omega)(\omega_{jg}+2\omega)(\omega_{nj}+\omega)} + \frac{e^{i(\omega_{ng}+\omega)t}-1}{(\omega_{mg}-\omega)(\omega_{jg}+2\omega)(\omega_{ng}+\omega)}\right.$$

$$-\frac{e^{i(\omega_{nj}-\omega)t}-1}{(\omega_{mg}+\omega)(\omega_{jg}+2\omega)(\omega_{nj}-\omega)} + \frac{e^{i(\omega_{nm}+2\omega)t}-1}{(\omega_{mg}+\omega)(\omega_{jm}+\omega)(\omega_{nm}+2\omega)} - \frac{e^{i(\omega_{nj}+\omega)t}-1}{(\omega_{mg}+\omega)(\omega_{jm}+\omega)(\omega_{nj}+\omega)}$$

$$-\frac{e^{i(\omega_{nm})t}-1}{(\omega_{mg}+\omega)(\omega_{jm}+\omega)(\omega_{nm})} + \frac{e^{i(\omega_{nj}-\omega)t}-1}{(\omega_{mg}+\omega)(\omega_{jm}+\omega)(\omega_{nj}-\omega)} + \frac{e^{i(\omega_{ng}+\omega)t}-1}{(\omega_{jg})(\omega_{mg}-\omega)(\omega_{ng}+\omega)}$$

$$-\frac{e^{i(\omega_{nj}+\omega)t}-1}{(\omega_{jg})(\omega_{mg}-\omega)(\omega_{nj}+\omega)} - \frac{e^{i(\omega_{ng}-\omega)t}-1}{(\omega_{jg})(\omega_{mg}-\omega)(\omega_{ng}-\omega)} + \frac{e^{i(\omega_{nj}-\omega)t}-1}{\omega_{jg}(\omega_{mg}-\omega)(\omega_{nj}-\omega)}$$

$$-\frac{e^{i(\omega_{nm}+2\omega)t}-1}{(\omega_{mg}-\omega)(\omega_{jm}+\omega)(\omega_{nm}+2\omega)} + \frac{e^{i(\omega_{nj}+\omega)t}-1}{(\omega_{mg}-\omega)(\omega_{jm}+\omega)(\omega_{nj}+\omega)} + \frac{e^{i(\omega_{nm})t}-1}{(\omega_{mg}-\omega)(\omega_{jm}+\omega)(\omega_{nm})}$$

$$-\frac{e^{i(\omega_{nj}-\omega)t}-1}{(\omega_{mg}-\omega)(\omega_{jm}-\omega)(\omega_{nj}-\omega)} + \frac{e^{i(\omega_{ng}+\omega)t}-1}{\omega_{jg}(\omega_{mg}+\omega)(\omega_{ng}+\omega)} - \frac{e^{i(\omega_{nj}+\omega)t}-1}{(\omega_{jg})(\omega_{mg}-\omega)(\omega_{nj}+\omega)}$$

$$-\frac{e^{i(\omega_{ng}-\omega)t}-1}{(\omega_{jg})(\omega_{mg}+\omega)(\omega_{ng}-\omega)} - \frac{e^{i(\omega_{nj}-\omega)t}-1}{(\omega_{jg})(\omega_{mg}+\omega)(\omega_{nj}-\omega)} - \frac{e^{i(\omega_{nm})t}-1}{(\omega_{mg}+\omega)(\omega_{jm}-\omega)(\omega_{nm})}$$

$$\left. + \frac{e^{i(\omega_{nj}-\omega)t}-1}{(\omega_{mg}+\omega)(\omega_{jm}-\omega)(\omega_{nj}+\omega)} + \frac{e^{i(\omega_{nm}-2\omega)t}-1}{(\omega_{mg}+\omega)(\omega_{jm}-\omega)(\omega_{nm}-2\omega)} - \frac{e^{i(\omega_{nj}-\omega)t}-1}{(\omega_{mg}+\omega)(\omega_{jm}-\omega)(\omega_{nj}-\omega)}\right]$$

87

$$-\frac{e^{i(\omega_{ng}-\omega)t}-1}{(\omega_{mg}-\omega)(\omega_{jg}-2\omega)(\omega_{ng}-\omega)} + \frac{e^{i(\omega_{nj}+\omega)t}-1}{(\omega_{mg}-\omega)(\omega_{jg}-2\omega)(\omega_{nj}+\omega)} + \frac{e^{i(\omega_{ng}-3\omega)t}-1}{(\omega_{mg}-\omega)(\omega_{jg}-2\omega)(\omega_{ng}-3\omega)}$$

$$-\frac{e^{i(\omega_{nj}-\omega)t}-1}{(\omega_{mg}-\omega)(\omega_{jg}-2\omega)(\omega_{nj}-\omega)} + \frac{e^{i(\omega_{nm})t}-1}{(\omega_{mg}-\omega)(\omega_{jm}-\omega)(\omega_{nm})} - \frac{e^{i(\omega_{nj}+\omega)t}-1}{(\omega_{mg}-\omega)(\omega_{jm}-\omega)(\omega_{nj}+\omega)}$$

$$-\frac{e^{i(\omega_{nm}-2\omega)t}-1}{(\omega_{mg}-\omega)(\omega_{jm}-\omega)(\omega_{nm}-2\omega)} + \frac{e^{i(\omega_{nj}-\omega)t}-1}{(\omega_{mg}-\omega)(\omega_{jm}-\omega)(\omega_{nj}-\omega)} \Biggr\}$$

The expectation of the polarization operator is then:

$$\langle \Psi|er|\Psi\rangle = \Biggl\langle \sum_n (\delta_{ng} + a_n^{(1)} + a_n^{(2)} + a_n^{(3)})\phi_n e^{-i\omega_n t} \Bigl| er \Bigr| \sum_m (\delta_{mg} + a_m^{(1)} + a_m^{(2)} + a_m^{(3)})$$

$$\phi_m e^{-i\omega_m t} \Biggr\rangle = \sum_n \sum_k e^{i(\omega_n - \omega_k)t} \Bigl[\delta_{ng}\delta_{kg} + \delta_{ng}a_k^{(1)} + a_n^{(1)*}\delta_{kg}$$

$$+ \delta_{ng}a_k^{(2)} + a_n^{(2)*}\delta_{kg} + a_n^{(1)*}a_k^{(1)} + a_n^{(2)*}a_k^{(2)} + a_n^{(1)*}a_k^{(2)}$$

$$+ a_n^{(2)*}a_k^{(1)} + a_n^{(3)*}\delta_{kg} + a_n^{(3)*}a_k^{(1)} + a_n^{(3)*}a_k^{(2)} + a_n^{(3)*}a_k^{(3)}$$

$$+ \delta_{ng}a_k^{(3)} + a_n^{(1)*}a_k^{(3)} + a_n^{(2)*}a_k^{(3)} \Bigr] \langle \phi_n|er|\phi_k\rangle .$$

The terms may be grouped according to frequency dependence, and according to which of the above terms they arose from. The number of terms is quite large and they will be written in an abbreviated form.

All terms up to third order, i.e., with three frequency factors in their denominators, will be listed explicitly, categorized by their frequency dependence, i.e., d.c., ωt, $2\omega t$, $3\omega t$. Terms of third order and lower order arise from the following combinations listed in the expectation of the polarization operator:

I. $\quad \delta_{ng}\delta_{kg}$

IV. $\quad a_n^{(1)*}a_k^{(1)}$

II. $\quad \delta_{ng}a_k^{(1)} + a_n^{(1)*}\delta_{kg}$

V. $\quad a_n^{(1)*}a_k^{(2)} + a_n^{(2)*}a_k^{(1)}$

III. $\quad \delta_{ng}a_k^{(2)} + a_n^{(2)*}\delta_{kg}$

VI. $\quad a_n^{(3)*}\delta_{kg} + \delta_{ng}a_k^{(3)}$

Besides those terms containing multiples of ωt, terms containing $\omega_{nm}t$, $\omega_{gn}t$ also are listed. Table I below lists the terms in accordance with their time dependence. The column on the right lists the terms from which they originate.

Terms of higher order also occur of course. These are in general small for two reasons, that the products of the matrix elements are generally smaller, the greater the number of factors, and the denominators are large, because of the greater number of factor. It is obvious that exceptions may occur because of resonance, i.e., a factor in the denominator approaching zero, or because of unusually large matrix elements. Such occurrences are sufficiently unusual so as to be unlikely and undependable. In illustration of the types of denominators which occur we list

$$\frac{1}{\omega_{ng}(\omega_{kg}+2\omega)(\omega_{mg}+\omega)^2} \qquad \frac{1}{(\omega_{nm}-\omega)(\omega_{km}+\omega)(\omega_{mg}-\omega)(\omega_{mg}+\omega)}$$

$$\frac{1}{(\omega_{ng}+2\omega)(\omega_{km}+\omega)(\omega_{mg}-\omega)(\omega_{mg}+\omega)} \qquad \frac{1}{(\omega_{nm}-\omega)(\omega_{km}-\omega)(\omega_{mg}-\omega)^2}$$

in the case of the term containing resonance factors, that is

$$\frac{1}{(\omega_{nm}-\omega)(\omega_{km}-\omega)(\omega_{mg}-\omega)^2}$$

the possibility of efficient operation arises if equally spaced energy levels can be found in a suitable material. Exactly equal spacing is unlikely, and even approximately equal spacing is not easy to find, as shown in the previous discussion in this report on asymmetric top energy levels. The effects of line broadening mechanisms have not been included here, but since they would allow approximate satisfaction of the resonance criteria, they must be taken into account in any design of nonlinear multiple quantum generators. They may be taken into account approximately by replacing the resonance denominators by factors containing reciprocal relaxation time terms.

TABLE I

D.C.

$$\sum_{n,m} \frac{e^2}{4\hbar^2} <\underline{E}_0 \cdot \underline{r}>_{ng} <\underline{E}_0 \cdot \underline{r}>_{mg} <n|er|k> \Big\{ \frac{1}{(\omega_{ng}+\omega)(\omega_{mg}+\omega)}$$

$$+ \frac{1}{(\omega_{ng}-\omega)(\omega_{mg}-\omega)} \Big\} \qquad\qquad \text{IV}$$

$$\sum_{n,m} \frac{e^2}{2\hbar^2} <\underline{E}_0 \cdot \underline{r}>_{nm} <\underline{E}_0 \cdot \underline{r}>_{mg} <n|er|g> \Big\{ \frac{-1}{(\omega_{mg}+\omega)(\omega_{ng})} - \frac{1}{(\omega_{mg}-\omega)(\omega_{ng})} \Big\} \qquad \text{III}$$

$$<g|er|g> \qquad\qquad \text{I}$$

$$\omega t$$

$$\sum_n \frac{e}{\hbar} <\underline{E}_0 \cdot \underline{r}>_{ng} <n|er|g> \Big\{ \sin \omega t \left(\frac{1}{\omega_{ng}+\omega} + \frac{1}{\omega_{ng}-\omega} \right) \qquad \text{II}$$

$$-\sum_n \frac{1}{4\hbar^3} \sum_j \sum_m a_g^0 <\phi_m|e\underline{E}_0 \cdot \underline{r}|\phi_g> <\phi_j|e\underline{E}_0 \cdot \underline{r}|\phi_m> <\phi_n|e\underline{E}_0 \cdot \underline{r}|\phi_j> <n|er|g>$$

$$\Big\{ \cos(\omega)t \Big[\frac{1}{(\omega_{mg}+\omega)(\omega_{jg}+2\omega)(\omega_{ng}+\omega)} + \frac{1}{(\omega_{jg})(\omega_{mg}-\omega)(\omega_{ng}+\omega)}$$

$$- \frac{1}{(\omega_{jg})(\omega_{mg}-\omega)(\omega_{ng}-\omega)} + \frac{1}{(\omega_{jg})(\omega_{mg}+\omega)(\omega_{ng}+\omega)} - \frac{1}{(\omega_{jg})(\omega_{mg}+\omega)(\omega_{ng}-\omega)}$$

$$- \frac{1}{(\omega_{mg}-\omega)(\omega_{jg}-2\omega)(\omega_{ng}-\omega)} \Big] \Big\} \qquad\qquad \text{VI}$$

$$\sum_{m,n,k} \frac{e^3}{8\hbar^3} <E_o \cdot r>_{ng} <E_o \cdot r>_{km} <E_o \cdot r>_{mg} <n|er|k> \left\{ \sin \omega t \right.$$

$$\left[\frac{1}{(\omega_{ng}+\omega)(\omega_{kg}+2\omega)(\omega_{mg}+\omega)} + \frac{1}{(\omega_{ng}+\omega)(\omega_{kg})(\omega_{mg}+\omega)} \right.$$

$$+ \frac{1}{(\omega_{n}+\omega)(\omega_{kg})(\omega_{mg}-\omega)} + \frac{1}{(\omega_{ng}-\omega)(\omega_{kg})(\omega_{mg}+\omega)} + \frac{1}{(\omega_{ng}-\omega)(\omega_{kg})(\omega_{mg}-\omega)}$$

$$\left. \left. + \frac{1}{(\omega_{ng}-\omega)(\omega_{kg}-2\omega)(\omega_{mg}-\omega)} \right] \right\} \qquad \text{V}$$

$$2\omega t$$

$$\sum_{n,m} \frac{e^2}{4\hbar^2} <E_o \cdot \underline{r}>_{ng} <E_o \cdot \underline{r}>_{mg} <n|er|k> \left\{ -\frac{\cos(2\omega)t}{(\omega_{ng}-\omega)(\omega_{mg}+\omega)} \right.$$

$$\left. - \frac{\cos(2\omega)t}{(\omega_{ng}+\omega)(\omega_{mg}-\omega)} \right\} \qquad \text{IV}$$

$$\sum_{n,m} \frac{e^2}{2\hbar^2} <E_o \cdot \underline{r}>_{nm} <E_o \cdot \underline{r}>_{mg} <n|er|g> \left\{ \frac{\cos(2\omega)t}{(\omega_{mg}+\omega)(\omega_{ng}+2\omega)} \right.$$

$$\left. + \frac{\cos(2\omega)t}{(\omega_{mg}-\omega)(\omega_{ng}-2\omega)} \right\} \qquad \text{III}$$

$$3\omega t$$

$$- \sum_n \frac{1}{4\hbar^3} \sum_j \sum_m a_g^o <\phi_m|e\underline{E}_o \cdot \underline{r}|\phi_g> <\phi_j|e\underline{E}_o \cdot \underline{r}|\phi_m> <\phi_n|e\underline{E}_o \cdot \underline{r}|\phi_j>$$

$$<n|er|g> \left\{ \frac{\cos(3\omega)t}{(\omega_{mg}-\omega)(\omega_{jg}-2\omega)(\omega_{ng}-3\omega)} - \frac{\cos(3\omega)t}{(\omega_{mg}+\omega)(\omega_{jg}+2\omega)(\omega_{ng}+3\omega)} \right\} \qquad \text{VI}$$

91

$$\sum_{m,n,k} \frac{e^3}{8\hbar^3} < E_0 \cdot r >_{ng} < E_0 \cdot r >_{km} < E_0 \cdot r >_{mg} < n|er|k > \left\{ - \sin \omega t \right.$$

$$\left. \left[\frac{1}{(\omega_{ng}+\omega)(\omega_{kg}-2\omega)(\omega_{mg}-\omega)} + \frac{1}{(\omega_{ng}-\omega)(\omega_{kg}+2\omega)(\omega_{mg}+\omega)} \right] \right\} \qquad V$$

$$\omega_{nm} t$$

$$\sum_{n,m} \frac{e^2}{4\hbar^2} < E_0 \cdot \underline{r} >_{ng} < E_0 \cdot \underline{r} >_{mg} < n|er|k > \left\{ \cos(\omega_{nm})t \left[\frac{1}{(\omega_{ng}+\omega)(\omega_{mg}+\omega)} \right. \right.$$

$$\left. \left. - \frac{1}{(\omega_{ng}-\omega)(\omega_{mg}+\omega)} - \frac{1}{(\omega_{ng}+\omega)(\omega_{mg}-\omega)} + \frac{1}{(\omega_{ng}-\omega)(\omega_{mg}-\omega)} \right] \right\} \qquad IV$$

$$\sum_{n} \frac{e}{\hbar} < E_0 \cdot \underline{r} >_{ng} < n|er|g > \left\{ \sin(\omega_{gn})t \left(\frac{1}{\omega_{ng}-\omega} - \frac{1}{\omega_{ng}+\omega} \right) \right\} \qquad II$$

$$\sum_{n,m} \frac{e^2}{2\hbar^2} < E_0 \cdot \underline{r} >_{nm} < E_0 \cdot \underline{r} >_{mg} < n|er|g > \left\{ \cos(\omega_{gn})t \left[- \frac{1}{(\omega_{mg}+\omega)(\omega_{ng}+2\omega)} \right. \right.$$

$$+ \frac{1}{(\omega_{mg}+\omega)(\omega_{ng})} + \frac{1}{(\omega_{mg}+\omega)(\omega_{nm}+\omega)} - \frac{1}{(\omega_{mg}+\omega)(\omega_{nm}-\omega)} + \frac{1}{(\omega_{mg}-\omega)(\omega_{ng})}$$

$$\left. \left. - \frac{1}{(\omega_{mg}-\omega)(\omega_{nm}+\omega)} - \frac{1}{(\omega_{mg}-\omega)(\omega_{ng}-2\omega)} + \frac{1}{(\omega_{mg}-\omega)(\omega_{nm}-\omega)} \right] \right\} \qquad III$$

$$-\sum_n \frac{1}{4\hbar^3} \sum_{jm} \sum_{g} a_g^0 <\emptyset_m|e\underline{E}_o \cdot \underline{r}|\emptyset_g><\emptyset_j|e\underline{E}_o \cdot \underline{r}|\emptyset_m><\emptyset_n|e\underline{E}_o \cdot \underline{r}|\emptyset_j><n|er|g>$$

$$\left\{(\cos(\omega_{gn})t)\left[\frac{1}{(\omega_{mg}+\omega)(\omega_{jg}+2\omega)(\omega_{ng}+3\omega)} - \frac{1}{(\omega_{mg}+\omega)(\omega_{jg}+2\omega)(\omega_{ng}+\omega)}\right.\right.$$

$$-\frac{1}{(\omega_{mg}+\omega)(\omega_{jg}+2\omega)(\omega_{ng}+\omega)} + \frac{1}{(\omega_{mg}+\omega)(\omega_{jg}+2\omega)(\omega_{nj}-\omega)}$$

$$-\frac{1}{(\omega_{mg}+\omega)(\omega_{jm}+\omega)(\omega_{nm}+2\omega)} + \frac{1}{(\omega_{mg}+\omega)(\omega_{jm}+\omega)(\omega_{nj}+\omega)}$$

$$-\frac{1}{(\omega_{mg}+\omega)(\omega_{jm}+\omega)(\omega_{nj}-\omega)} - \frac{1}{(\omega_{jg})(\omega_{mg}-\omega)(\omega_{ng}+\omega)}$$

$$+\frac{1}{(\omega_{jg})(\omega_{mg}-\omega)(\omega_{nj}+\omega)} + \frac{1}{(\omega_{jg})(\omega_{mg}-\omega)(\omega_{ng}-\omega)} - \frac{1}{(\omega_{jg})(\omega_{mg}-\omega)(\omega_{nj}-\omega)}$$

$$+\frac{1}{(\omega_{mg}-\omega)(\omega_{jm}+\omega)(\omega_{nm}+2\omega)} - \frac{1}{(\omega_{mg}-\omega)(\omega_{jm}+\omega)(\omega_{nj}+\omega)}$$

$$+\frac{1}{(\omega_{mg}-\omega)(\omega_{jm}+\omega)(\omega_{nj}-\omega)} - \frac{1}{(\omega_{jg})(\omega_{mg}+\omega)(\omega_{ng}+\omega)}$$

$$+\frac{1}{(\omega_{jg})(\omega_{mg}+\omega)(\omega_{nj}+\omega)} + \frac{1}{(\omega_{jg})(\omega_{mg}+\omega)(\omega_{ng}-\omega)} - \frac{1}{(\omega_{jg})(\omega_{mg}+\omega)(\omega_{nj}-\omega)}$$

$$-\frac{1}{(\omega_{mg}+\omega)(\omega_{jm}-\omega)(\omega_{nj}+\omega)} - \frac{1}{(\omega_{mg}+\omega)(\omega_{jm}-\omega)(\omega_{nm}-2\omega)}$$

$$+\frac{1}{(\omega_{mg}+\omega)(\omega_{jm}-\omega)(\omega_{nj}-\omega)} + \frac{1}{(\omega_{mg}-\omega)(\omega_{jg}-2\omega)(\omega_{ng}-\omega)}$$

$$-\frac{1}{(\omega_{mg}-\omega)(\omega_{jg}-2\omega)(\omega_{nj}+\omega)} - \frac{1}{(\omega_{mg}-\omega)(\omega_{jg}-2\omega)(\omega_{ng}-3\omega)}$$

$$+\frac{1}{(\omega_{mg}-\omega)(\omega_{jg}-2\omega)(\omega_{nj}-\omega)} + \frac{1}{(\omega_{mg}-\omega)(\omega_{jm}-\omega)(\omega_{nj}+\omega)}$$

93

$$+ \frac{1}{(\omega_{mg} - \omega)(\omega_{jm} - \omega)(\omega_{nm} - 2\omega)} - \frac{1}{(\omega_{mg} - \omega)(\omega_{jm} - \omega)(\omega_{nj} - \omega)} \Big]$$

$$+ (-\cos(\omega_{gm})t + \cos(\omega_{gn})t) \Big[\frac{1}{(\omega_{mg} + \omega)(\omega_{jm} + \omega)(\omega_{nm})}$$

$$+ \frac{1}{(\omega_{mg} + \omega)(\omega_{jm} - \omega)(\omega_{nm})} \Big] + (\cos(\omega_{gm})t - \cos(\omega_{gn})t)$$

$$\Big[\frac{1}{(\omega_{mg} - \omega)(\omega_{jm} + \omega)(\omega_{nm})} + \frac{1}{(\omega_{mg} - \omega)(\omega_{jm} - \omega)(\omega_{nm})} \Big] \Big\}$$

VI

$$\omega_{\gamma\beta} t$$

$$\sum_{m,n,k} \frac{e^3}{8\hbar^3} <E_o \cdot r>_{ng} <E_o \cdot r>_{km} <E_o \cdot r>_{mg} <n|er|k> \{ \sin(\omega_{mg})t$$

$$\Big[\frac{1}{(\omega_{ng} + \omega)(\omega_{km} + \omega)(\omega_{mg} + \omega)} + \frac{1}{(\omega_{ng} - \omega)(\omega_{km} - \omega)(\omega_{mg} + \omega)} \Big] - \sin(\omega_{mg})t$$

$$\Big[\frac{1}{(\omega_{ng} + \omega)(\omega_{km} + \omega)(\omega_{mg} - \omega)} + \frac{1}{(\omega_{ng} - \omega)(\omega_{km} - \omega)(\omega_{mg} - \omega)} \Big] + \sin(\omega_{ng})t$$

$$\Big[\frac{1}{(\omega_{ng} + \omega)(\omega_{kg})(\omega_{mg} + \omega)} + \frac{1}{(\omega_{ng} + \omega)(\omega_{kg})(\omega_{mg} - \omega)} \Big] - \sin(\omega_{ng})t$$

$$\Big[\frac{1}{(\omega_{ng} - \omega)(\omega_{kg})(\omega_{mg} + \omega)} + \frac{1}{(\omega_{ng} - \omega)(\omega_{kg})(\omega_{mg} - \omega)} \Big] + \sin(\omega_{nk})t$$

$$\Big[\frac{1}{(\omega_{ng} + \omega)(\omega_{kg} + 2\omega)(\omega_{mg} + \omega)} - \frac{1}{(\omega_{ng} + \omega)(\omega_{kg})(\omega_{mg} + \omega)}$$

$$- \frac{1}{(\omega_{ng} + \omega)(\omega_{km} + \omega)(\omega_{mg} + \omega)} + \frac{1}{(\omega_{ng} + \omega)(\omega_{km} - \omega)(\omega_{mg} + \omega)}$$

$$- \frac{1}{(\omega_{ng} + \omega)(\omega_{kg})(\omega_{mg} - \omega)} + \frac{1}{(\omega_{ng} + \omega)(\omega_{km} + \omega)(\omega_{mg} - \omega)}$$

$$+ \frac{1}{(\omega_{ng} + \omega)(\omega_{kg} - 2\omega)(\omega_{mg} - \omega)} - \frac{1}{(\omega_{ng} + \omega)(\omega_{km} - \omega)(\omega_{mg} - \omega)}$$

$$- \frac{1}{(\omega_{ng} - \omega)(\omega_{kg} + 2\omega)(\omega_{mg} + \omega)} + \frac{1}{(\omega_{ng} - \omega)(\omega_{kg})(\omega_{mg} + \omega)}$$

$$+ \frac{1}{(\omega_{ng} - \omega)(\omega_{km} + \omega)(\omega_{mg} + \omega)} - \frac{1}{(\omega_{ng} - \omega)(\omega_{km} - \omega)(\omega_{mg} + \omega)}$$

$$+ \frac{1}{(\omega_{ng} - \omega)(\omega_{kg})(\omega_{mg} - \omega)} - \frac{1}{(\omega_{ng} - \omega)(\omega_{km} + \omega)(\omega_{mg} - \omega)}$$

$$- \frac{1}{(\omega_{ng} - \omega)(\omega_{kg} - 2\omega)(\omega_{mg} - \omega)} + \frac{1}{(\omega_{ng} - \omega)(\omega_{km} - \omega)(\omega_{mg} - \omega)} \Big] \Big\}$$

V

$$(\omega_{ng} \pm \omega)t$$

$$\sum_{m,n,k} \frac{e^3}{8\hbar^3} <E_o \cdot r>_{ng} <E_o \cdot r>_{km} <E_o \cdot r>_{mg} <n|er|k> \Big\{ \sin(\omega_{kg} + \omega)t$$

$$\Big[\frac{1}{(\omega_{ng} + \omega)(\omega_{kg} + 2\omega)(\omega_{mg} + \omega)} - \frac{1}{(\omega_{ng} + \omega)(\omega_{kg})(\omega_{mg} + \omega)}$$

$$- \frac{1}{(\omega_{ng} + \omega)(\omega_{km} + \omega)(\omega_{mg} + \omega)} + \frac{1}{(\omega_{ng} + \omega)(\omega_{km} - \omega)(\omega_{mg} + \omega)}$$

$$- \frac{1}{(\omega_{ng} + \omega)(\omega_{kg})(\omega_{mg} - \omega)} + \frac{1}{(\omega_{ng} + \omega)(\omega_{km} + \omega)(\omega_{mg} - \omega)}$$

$$+ \frac{1}{(\omega_{ng} + \omega)(\omega_{kg} - 2\omega)(\omega_{mg} - \omega)} - \frac{1}{(\omega_{ng} + \omega)(\omega_{km} - \omega)(\omega_{mg} - \omega)} \Big] + \sin(\omega_{kg} - \omega)t$$

$$\Big[- \frac{1}{(\omega_{ng} - \omega)(\omega_{kg} + 2\omega)(\omega_{mg} + \omega)} + \frac{1}{(\omega_{ng} - \omega)(\omega_{kg})(\omega_{mg} + \omega)}$$

85

$$+ \frac{1}{(\omega_{ng}- \omega)(\omega_{km}+ \omega)(\omega_{mg}+ \omega)} - \frac{1}{(\omega_{ng}- \omega)(\omega_{km}- \omega)(\omega_{mg}+ \omega)}$$

$$+ \frac{1}{(\omega_{ng}- \omega)(\omega_{kg})(\omega_{mg}- \omega)} - \frac{1}{(\omega_{ng}- \omega)(\omega_{km}+ \omega)(\omega_{mg}- \omega)}$$

$$- \frac{1}{(\omega_{ng}- \omega)(\omega_{kg}- 2\omega)(\omega_{mg}- \omega)} + \left. \frac{1}{(\omega_{ng}- \omega)(\omega_{km}- \omega)(\omega_{mg}- \omega)} \right] + \sin(\omega_{nm}+ \omega)t$$

$$\left[\frac{1}{(\omega_{ng}+ \omega)(\omega_{km}+ \omega)(\omega_{mg}+ \omega)} + \frac{1}{(\omega_{ng}- \omega)(\omega_{km}+ \omega)(\omega_{mg}- \omega)} \right] - \sin(\omega_{nm}+ \omega)t$$

$$\left[\frac{1}{(\omega_{ng}+ \omega)(\omega_{km}+ \omega)(\omega_{mg}- \omega)} + \frac{1}{(\omega_{ng}- \omega)(\omega_{km}+ \omega)(\omega_{mg}+ \omega)} \right] + \sin(\omega_{nm}- \omega)t$$

$$\left[\frac{1}{(\omega_{ng}+ \omega)(\omega_{km}- \omega)(\omega_{mg}- \omega)} + \frac{1}{(\omega_{ng}- \omega)(\omega_{km}- \omega)(\omega_{mg}+ \omega)} \right] - \sin(\omega_{nm}- \omega)t$$

$$\left. \left[\frac{1}{(\omega_{ng}+ \omega)(\omega_{km}- \omega)(\omega_{mg}+ \omega)} + \frac{1}{(\omega_{ng}- \omega)(\omega_{km}- \omega)(\omega_{mg}- \omega)} \right] \right\}$$ V

$$(\omega_{\alpha_\beta} \pm \omega)t$$

$$\sum_{n,m} \frac{e^2}{4\hbar^2} < \varepsilon_0 \cdot \underline{r} >_{ng} < \varepsilon_0 \cdot \underline{r} >_{mg} < n|er|k > \left\{ (\cos(\omega_{gn}- \omega)t + \cos(\omega_{gm}+ \omega)t) \right.$$

$$\left(\frac{1}{(\omega_{ng}- \omega)(\omega_{mg}+ \omega)} + \frac{1}{(\omega_{ng}+ \omega)(\omega_{mg}- \omega)} \right) + (-\cos(\omega_{gn}- \omega)t - \cos(\omega_{gm}- \omega)t)$$

$$\left. \left(\frac{1}{(\omega_{ng}+ \omega)(\omega_{mg}+ \omega)} + \frac{1}{(\omega_{ng}- \omega)(\omega_{mg}- \omega)} \right) \right\}$$ IV

96

$$\sum_{n,m} \frac{e^2}{2\hbar^2} <\underline{\varepsilon}_0 \cdot \underline{r}>_{nm} \cdot \underline{\varepsilon}_0 \cdot \underline{r}>_{mg} <n|er|g> \left\{ \cos(\omega_{gm}+\omega)t \left[\frac{-1}{(\omega_{mg}+\omega)(\omega_{nm}+\omega)} \right. \right.$$

$$\left. + \frac{1}{(\omega_{mg}-\omega)(\omega_{nm}+\omega)} \right] + \cos(\omega_{gm}-\omega)t \left[\frac{1}{(\omega_{mg}+\omega)(\omega_{nm}-\omega)} \right.$$

$$\left. \left. - \frac{1}{(\omega_{mg}-\omega)(\omega_{nm}-\omega)} \right] \right\} \qquad\qquad \text{III}$$

$$-\sum_{n} \frac{1}{4\hbar^3} \sum_{j}\sum_{m} a_g^o <\phi_m|e\underline{\varepsilon}_0 \cdot \underline{r}|\phi_g> <\phi_j|e\underline{\varepsilon}_0 \cdot \underline{r}|\phi_m> <\phi_n|e\underline{\varepsilon}_0 \cdot \underline{r}|\phi_j> <n|er|g>$$

$$\left\{ \cos(\omega_{gj}+\omega)t \left[\frac{1}{(\omega_{mg}+\omega)(\omega_{jg}+2\omega)(\omega_{nj}+\omega)} - \frac{1}{(\omega_{mg}+\omega)(\omega_{jm}+\omega)(\omega_{nj}+\omega)} \right. \right.$$

$$- \frac{1}{(\omega_{jg})(\omega_{mg}-\omega)(\omega_{nj}+\omega)} + \frac{1}{(\omega_{mg}-\omega)(\omega_{jm}+\omega)(\omega_{nj}+\omega)}$$

$$- \frac{1}{(\omega_{jg})(\omega_{mg}+\omega)(\omega_{nj}+\omega)} + \frac{1}{(\omega_{mg}+\omega)(\omega_{jm}-\omega)(\omega_{nj}+\omega)}$$

$$\left. + \frac{1}{(\omega_{mg}-\omega)(\omega_{jg}-2\omega)(\omega_{nj}+\omega)} - \frac{1}{(\omega_{mg}-\omega)(\omega_{jm}-\omega)(\omega_{nj}+\omega)} \right] + \cos(\omega_{gj}-\omega)t$$

$$\left[- \frac{1}{(\omega_{mg}+\omega)(\omega_{jg}+2\omega)(\omega_{nj}-\omega)} + \frac{1}{(\omega_{mg}+\omega)(\omega_{jm}+\omega)(\omega_{nj}-\omega)} \right.$$

$$+ \frac{1}{(\omega_{jg})(\omega_{mg}-\omega)(\omega_{nj}-\omega)} - \frac{1}{(\omega_{mg}-\omega)(\omega_{jm}+\omega)(\omega_{nj}-\omega)}$$

$$+ \frac{1}{(\omega_{jg})(\omega_{mg}+\omega)(\omega_{nj}-\omega)} - \frac{1}{(\omega_{mg}+\omega)(\omega_{jm}-\omega)(\omega_{nj}-\omega)}$$

$$\left. \left. - \frac{1}{(\omega_{mg}-\omega)(\omega_{jg}-2\omega)(\omega_{nj}-\omega)} + \frac{1}{(\omega_{mg}-\omega)(\omega_{jm}-\omega)(\omega_{nj}-\omega)} \right] \right\} \qquad \text{VI}$$

$$(\omega_{ng} \pm 2\omega)t$$

$$\sum_{m,n,k} \frac{e'}{8\hbar^3} <\underline{E}_o \cdot r>_{ng} <\underline{E}_o \cdot r>_{km} <\underline{E}_o \cdot r>_{mg} <n|er|k> \left\{ \sin(\omega_{mg} - 2\omega)t \right.$$

$$\left[\frac{1}{(\omega_{ng}-\omega)(\omega_{km}+\omega)(\omega_{mg}-\omega)} - \frac{1}{(\omega_{ng}-\omega)(\omega_{km}+\omega)(\omega_{mg}+\omega)}\right] + \sin(\omega_{mg}+2\omega)t$$

$$\left[\frac{1}{(\omega_{ng}+\omega)(\omega_{km}-\omega)(\omega_{mg}-\omega)} - \frac{1}{(\omega_{ng}+\omega)(\omega_{km}-\omega)(\omega_{mg}+\omega)}\right] + \sin(\omega_{ng}+2\omega)t$$

$$\left[-\frac{1}{(\omega_{ng}+\omega)(\omega_{kg}+2\omega)(\omega_{mg}+\omega)} + \frac{1}{(\omega_{ng}-\omega)(\omega_{kg}+2\omega)(\omega_{mg}+\omega)}\right] + \sin(\omega_{ng}-2\omega)t$$

$$\left.\left[\frac{1}{(\omega_{ng}-\omega)(\omega_{kg}-2\omega)(\omega_{mg}-\omega)} - \frac{1}{(\omega_{ng}+\omega)(\omega_{kg}-2\omega)(\omega_{mg}-\omega)}\right]\right\} \qquad \text{V}$$

$$- \sum_{n} \frac{1}{4\hbar^3} \sum_{jm} a_g^o <\phi_m|e\underline{E}_o \cdot \underline{r}|\phi_g> <\phi_j|e\underline{E}_o \cdot \underline{r}|\phi_m> <\phi_n|e\underline{E}_o \cdot \underline{r}|\phi_j> <n|er|g>$$

$$\left\{\cos(\omega_{gm}+2\omega)t\left[\frac{1}{(\omega_{mg}+\omega)(\omega_{jm}+\omega)(\omega_{nm}+2\omega)} - \frac{1}{(\omega_{mg}-\omega)(\omega_{jm}+\omega)(\omega_{nm}+2\omega)}\right]\right.$$

$$+ \cos(\omega_{gm}-2\omega)t \frac{1}{(\omega_{mg}+\omega)(\omega_{jm}-\omega)(\omega_{nm}-2\omega)}$$

$$\left.\left. - \frac{1}{(\omega_{mg}-\omega)(\omega_{jm}-\omega)(\omega_{nm}-2\omega)}\right]\right\} \qquad \text{VI}$$

98

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13 ABSTRACT The difficulty of obtaining a large filling factor with crossed interferometers at the fundamental and harmonic frequency was discussed in the last quarterly report. The use of a beam splitter to couple the two frequencies has been proposed. The design and preliminary testing of a metal strip and a dielectric sheet beam splitter is a difficult task because of the necessity of preserving the resonator Q with the beam splitter installed. This problem is discussed.

Several asymmetric gases for use in the totally resonant are still under investigation. Due to the corrosive and toxic properties of many of these gases, emphasis has been placed on a search for a gas with the proper energy levels that can be handled in a conventional vacuum system. A tabulation of gases under consideration, and their toxicity and handling problems, is given in the body of this report. Methylene chloride, methylene fluoride, and difluoroethylene appear to have the best handling characteristics. A possible scheme for pumping methylene chloride has been found. Further evaluation of the other gases has been started. Energy levels for methylene fluoride, difluoroethylene, formaldehyde, vinyl cyanide, benzonitrile and nitrosyl chloride are given in Appendix A. A nickel model vacuum system was constructed to test the corrosive properties of these gases.

The experimental effort during the fourth quarter is reviewed. Major emphasis was placed on high power tests for the two-level scheme and parallel plate interferometer and beam splitting tests for the totally resonant system. In the area of the two-level system a sapphire window has been designed and fabricated. This window was successfully operated at 30 kw in a corrosive atmosphere. Martin-Orlando purchased an inverted coaxial tunable magnetron to replace the Microwave Associates' magnetron. Since methyl fluoride decomposes forming hydrofluoric acid in the presence of the high power microwave field, the microwave plumbing has been nickel plated. Fluoroform gas has also been tried in the two-level system. This gas is very inert thermally and did not decompose when the high power microwave energy was applied. The totally resonant experiments included tests on the gold plated nickel interferometers at 40 GHz. Beam splitters were designed and tests performed. Quantum mechanical calculations were performed to determine the transition probabilities for nonlinear effect.

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